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Official Journal American Congress of Physical Medicine

(Formerly Archives of Physical Therapy)

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27th Annual Session
AMERICAN CONGRESS OF PHYSICAL MEDICINE

September 6, 7, 8, 9, 10, 1949

NETHERLAND PLAZA CINCINNATI, OHIO

VOLUME XXX APRIL, 1949 NO. 4

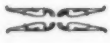
American Congress of Physical Medicine

27th Annual

Scientific and Clinical Session

Instruction Course

September 6, 7, 8, 9 and 10, 1949



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Physicians only may enroll for letter series

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(A) 10:00-10:50 A.M. Functional Anatomy of Shoulder and Arm Movie Demonstration Parlor H	(B) 11:00-11:50 A.M. Functional Anatomy of Hand Movie Demonstration Parlor H	
TUESDAY AFTERNOON — SEPTEMBER 6		
(C) 3:00-3:50 P.M. Therapeutic Exercise: Basic Principles Underlying Parlor H	(D) 4:00-4:50 P.M. Therapeutic Exercise: Neurophysiology as Related to Parlor H	
WEDNESDAY MORNING — SEPTEMBER 7		
(E) 8:30-9:20 A.M. Functional Anatomy of Hip and Thigh Movie Demonstration Parlor H	(F) 9:30-10:20 A.M. Functional Anatomy of Lower Leg and Knee Movie Demonstration Parlor H	
THURSDAY MORNING — SEPTEMBER 8		
(G) 8:30-9:20 A.M. Movement Patterns in Infants and Children Parlor H	(H) 9:30-10:20 A.M. Movement Patterns in Infants and Children Parlor H	
FRIDAY MORNING — SEPTEMBER 9		
(J) 8:30-9:20 A.M. Recent Developments in Physiology of Exercise Parlor H	(K) 9:30-10:20 A.M. Application of Electrical Principles to Vascular and Cardiovascular Problems Parlor H	

Physicians and registered physical therapy technicians may enroll for numbered series

TUESDAY MORNING — SEPTEMBER 6		
(1) 10:00-10:50 A.M. Braces: Anatomic Considerations in Prescribing and Fitting Parlor I	(2) 11:00-11:50 A.M. Special Braces to Favor Functional Activity Parlor I	
TUESDAY AFTERNOON — SEPTEMBER 6		
(3) 3:00-3:50 P.M. Electrodiagnosis: Clinical Uses and Interpretation of Golseth-Fizzell Apparatus Parlor I	(4) 4:00-4:50 P.M. Multiple Sclerosis: Evaluation and Prognosis for Physical Rehabilitation Parlor I	
WEDNESDAY MORNING — SEPTEMBER 7		
(5) 8:30-9:20 A.M. Muscular Imbalance: Evaluation and Treatment Parlor I	(6) 9:30-10:20 A.M. Research in Brace Making Parlor I	
THURSDAY MORNING — SEPTEMBER 8		
(7) 8:30-9:20 A.M. Cerebral Palsy (Spastics): Diagnosis and Prognosis Parlor I	(8) 9:30-10:20 A.M. Cerebral Palsy (Spastic) Patients: Muscle Reeducation Parlor I	
FRIDAY MORNING — SEPTEMBER 9		
(9) 8:30-9:20 A.M. Development of a Rehabilitation Center Parlor I	(10) 9:30-10:20 A.M. Muscle Strength Testing: Method, Interpretation and Importance in Evaluation for Rehabilitation Parlor I	

Note: The Committee on Education of the American Congress of Physical Medicine is in charge of the instruction course. It is purposely planned to limit the subjects in any year to a few topics in order to devote enough time to those subjects to give those attending a good review, both from the standpoint of basic knowledge and from the clinical standpoint. Certain groups of these subjects will be repeated every three to five years.

Courses will be offered in two separate groups: One group of ten lectures will be offered on basic subjects and this group will be open only to physicians. A second group of ten lectures will present more general and clinical subjects. Physicians and physical therapy technicians may register for the second group of lectures. Only those physical therapy technicians who are registered with the American Registry of Physical Therapy Technicians will be permitted to enroll for instruction courses.

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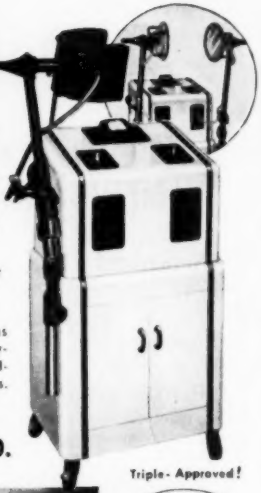

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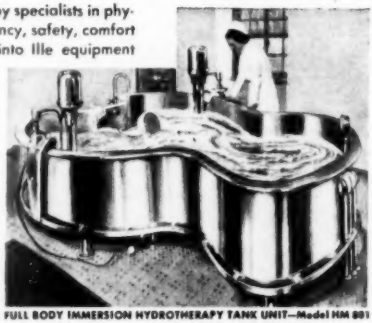

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Contents—Apr. 1949

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ARCHIVES OF PHYSICAL MEDICINE
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ORIGINAL ARTICLES

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EDITOR OF THE MONTH

ARTHUR L. WATKINS, M.D.
Boston, Massachusetts

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Mills College, Oakland, Calif.	Mills College	3 yrs.	FebSept	Degree	$200 $550	Certificate	....
San Jose State College, San Jose, Calif.	San Jose State College	1½ yrs. 3¼ yrs.	Varies Varies	Degree High sch.	$ 21 $ 21	Certificate Degree	10
University of Illinois College of Medicine, 1853 W. Polk St., Chicago	University of Illinois	5 yrs.	Feb	High sch.	$152	B.S.	14
University of Iowa, Iowa City, Iowa	State University of Iowa, College of Medicine	5 yrs.	.....	High sch.	$ 85	Cert.&Deg	
University of Kansas, Lawrence	University of Kansas	**2 yrs.** **4 yrs.**	**FebSept** **FebSept**	Degree High sch.	$131 $131	Certificate B.S.	10
Boston School of Occupational Therapy, 7 Harcourt St., Boston	Tufts College	2 yrs. 5 yrs.	Sept Sept	Degree High sch.	$500 $450	Diploma B.S.	13
Wayne University, 4841 Cass, Detroit, Mich.	Wayne University, College of Med., Coll. of Liberal Arts, Coll. of Education	5 yrs.	.....	High sch.	.....	.....	
Kalamazoo School of Occupational Therapy, Western Michigan College of Education, Kalamazoo	Western Michigan College of Education	1½ yrs. **4 yrs.**	FebSept **FebSept**	Degree 1 yr. coll.	$127 $127	Diploma Degree	20
Michigan State Normal College, Ypsilanti	University of Michigan	5 yrs.	Varies	High sch.	$118	Cert.&Deg.	8
University of Minnesota, Church Street, Minneapolis	University of Minnesota	4 yrs.	.....	High sch.	$360	B.S.	
College of St. Catherine, St. Paul, Minn.	The College of St. Catherine	3½ yrs.	Varies	1 yr. coll.	$210	Degree	4
Washington University School of Medicine, St. Louis	Washington University	3 yrs.	Sept	2 yrs. coll.	$400	Degree	10
University of New Hampshire, Durham	**Univ. of New Hampshire**	**5 yrs.**	**Sept**	**High sch.**	**$160**	Cert.&Deg.	6
Columbia University College of Physicians and Surgeons, 630 W. 168th St., New York City	Columbia University	1½ yrs. 2½ yrs.	Sept Sept	**Degree** **2 yrs. coll.**	**$450** **$450**	Certificate Degree	28
New York University School of Education, 100 Washington Sq. E., New York City	New York University	4½ yrs.	FebSept	High sch.	$500	Cert.&Deg.	20
Ohio State University, Columbus	Ohio State University	3 yrs.	Quarterly	High sch.	$105	Degree	21
Philadelphia School of Occupational Therapy, 419 S. 19th St., Philadelphia	University of Pennsylvania	1½ yrs. 3 yrs.	Sept Sept	Degree 1 yr. coll. High sch.	$500 $500 $600	Diploma Diploma	35
Texas State College for Women, Denton, Tex.	Texas State College for Women	5 yrs.	FebSept	High sch.	$150	Degree	13
Richmond Professional Institute, 901 W. Franklin St., Richmond, Va.	Medical College of Virginia	1½ yrs. **3 yrs.**	Sept **Sept**	**Degree** **1 yr. coll.**	**$200** **$200**	Certificate Certificate	20
College of Puget Sound, Tacoma, Wash.	College of Puget Sound	3 yrs. 5 yrs.	FebSept FebSept	Degree High sch.	$350 $300	Certificate Cert.&Deg.	
University of Wisconsin, Madison	University of Wisconsin	4 yrs.	FebSept	High sch.	$320	Cert.&Deg.	8
Milwaukee-Downer College, Dept. of Occupational Therapy, 2512 E. Hartford, Milwaukee	Milwaukee-Downer College	2½ yrs. 4 yrs.	Sept Sept	1 yr. coll. High sch.	$300 $300	Diploma Dipl.&Deg.	22
Mount Mary College, 2900 Menomonee River Dr., Milwaukee		Varies	Sept	Degree	$335	Certificate	15
University of Toronto, Dept. of University Extension, Toronto, Ont., Canada	**University of Toronto**	5 yrs. **3 yrs.**	Sept **Sept**	High sch. 1 yr. coll.	$260 $222	B.S.Deg. Diploma	110
Colorado Agricultural and Mechanical College, Fort Collins, Colorado		5 yrs.	Sept	High sch.	.....	B.S.	

* Rep. in part J. A. M. A. **137**:1460 (Aug.) 1948.

Name and Location of School	Medical Director Technical Director	College Affiliation	Entrance Requirements *	Duration of Course	Time of Admission	Maximum Enrollment	Tuition	Certificate, Diploma, Degree
Childrens Hospital, Los Angeles	Samuel Mathews, M.D. Miss Sarah S. Rogers	Univ. Calif. at Los Angeles	a-b-d	14 mos.	Sept	14	$300	Cert. or Deg.[11]
College of Medical Evangelists Los Angeles[1]	Fred B. Moor, M.D. R. William Berdan	School of Medicine Coll. Med. Evangelists	a-b-c-d	12 mos.	Sept	20	$225	Cert. or Dipl.
University of California Medical School, San Francisco[1]	Lucille Eising, M.D. Mrs. Margery L. Wagner	Univ. Calif.	d-e	12 mos.	Sept	12	$220[3]	Cert. or Degree
Stanford University, Stanford University, Calif.[1]	W. H. Northway, M.D. Miss Lucille Daniels	Stanford Univ.	a-b-d	12 mos.	JanJune	48	$523.30	Cert. or Degree
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Bouvé-Boston School of Physical Education, Boston	Howard Moore, M.D. Miss Constance K. Greene	Tufts Coll.	c[4]	4 yrs.	Sept	15	$250[3]	Cert. or Degree
Boston University, College of Physical Education for Women, Sargent College, Cambridge, Mass.	Kenneth Christophe, M.D. Miss Adelaide L. McGarrett	Boston Univ. Med. Sch.	H.S.	4 yrs.	Sept	25	$450	Diploma or Degree
University of Minnesota, Minneapolis[1]	M. E. Knapp, M.D. Miss Ruby Green	Univ. Minn.	H.S.	4 yrs.	Oct	16	$530[3,9]	Degree
Washington U. School of Medicine,[1] Barnes Hospital, St. Louis	S. Mead, M.D. Miss Beatrice F. Schulz	Wash. Univ. Sch. Med.	c	2 yrs.	Sept	20	$400 yr.[12]	Degree
St. Louis University School of Nursing, St. Louis[1]	A. J. Kotkis, M.D. Sister Mary Imelda	St. Louis Univ.	a[2]	4 yrs.	Sept	12	$300 yr.	Cert. or Degree
Columbia University, College of Physicians and Surgeons, New York City[1]	William B. Snow, M.D. Miss Josephine L. Rathbone	Columbia Univ.	a-b-c[6]	2 yrs.	Sept	35	$450 yr.	Cert. or Degree
New York University School of Education New York City[1]	George G. Deaver, M.D. Miss Elizabeth C. Addoms	New York Univ.	a-b-d	12 mos.	Sept	40	$525	Cert. & Degree
Duke University School of Medicine, Durham, N. C.[1]	Lenox D. Baker, M.D. Miss Helen Kaiser	Duke Univ.	a-b-d	15 mos.	Oct	12	$300	Certificate
D. T. Watson School of Physiotherapy, Leetsdale, Pa.[1]	Jessie Wright, M.D. Miss Kathryn Kelley	Univ. Pittsburgh	a-b-d	12 mos.	Oct	30	$300	Dipl. or Degree
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University of Wisconsin Medical School, Madison[1]	Harry D. Bouman, M.D. Miss Margaret A. Kohli	Univ. Wis.	H.S.	4 yrs.	Sept-Feb	20	$480[3,9]	Cert. & Degree
University Southern California, Los Angeles	Charles L. Lowman, M.D. Charlotte Anderson	Univ. of S. Calif	d[2]	12 mos.	Sept	16	$374	Certificate
Albany Hospital, Albany, N. Y.	John Ghormley, M. D. Catharine Graham	None	a-b-d	12 mos.	Sept	6	$250	Certificate
Mayo Clinic Section on Physical Medicine, Rochester, Minnesota	Earl C. Elkins, M.D. Miss Helen Belknap	None	a-b-c	12 mos.	Sept	30	none	Certificate
Simmons College Program in Physical Therapy, Boston	William T. Green, M.D. Arthur L. Watkins, M.D. Miss Janet B. Merrill	School of Science Simmons College	a[7]-b[7]-d-e[8]	16 mos.	Sept	25	$650	Diploma or Diploma and Degree[8]
University of Colorado Medical Center, Denver, Colorado[1]	Harold Dinken, M.D. Miss Mary Lawrence	University of Colorado Medical Center	a-b-d	12 mos.	Sept	Varies	$300[3]	Certificate
Hermann Hospital School of Physical Therapy, Houston, Texas	Oscar O. Selke, Jr., M. D. Miss Mary E. Kolb	University of Houston	a-b-d	12 mos.	Oct	12	$300	Cert. or Degree

* Courses are so arranged that any of the entrance requirements will qualify students for training. a = Graduation from accredited school of nursing; b = Graduation from accredited school of physical education; c = Two years of college with science courses; d = Three years of college with science courses; e = Four years of college with science courses; H. S. = High school graduation; f = degree in physical education or science; g = graduation from an accredited college or university with a B.A. or B.S. degree and at least twenty-six hours in biological and physical sciences.

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† Rep. in part Nov., 1947, with additions from J. A. M. A. 133:1149 (April 12) 1947.

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A COMPARATIVE STUDY OF THE TEMPERATURES PRODUCED BY MICROWAVE AND SHORT WAVE DIATHERMY *

JAMES W. RAE, JR., M.D.
Fellow in Physical Medicine, Mayo Foundation

J. F. HERRICK, Ph.D.
Division of Experimental Medicine, Mayo Foundation

KHALIL G. WAKIM, M.D., Ph.D.
Section on Physiology, Mayo Clinic

and

FRANK H. KRUSEN, M.D.
Section on Physical Medicine, Mayo Clinic

ROCHESTER, MINN.

With the development of the multicavity magnetron a new type of diathermy became available. When preliminary studies with microwaves demonstrated that the temperatures developed in tissues could satisfactorily meet the requirements set by the Council on Physical Medicine of the American Medical Association, we considered it timely to make a comparative study of the heating produced by microwaves and by the older method of short wave diathermy. As is well known, short wave diathermy is an important and much used therapeutic agent in physical medicine. Now that microwave diathermy is being used clinically, the question arises as to what advantages, if any, one form of diathermy has over the other. An accurate study would be of immediate practical clinical value. The work reported in this paper is concerned only with the heating produced by short wave and by microwave diathermy.

The literature on short wave diathermy is voluminous. The review in this article is limited to reports on tissue heating, the subject of our immediate concern. In 1934 Merriman, Holmquest and Osborne[1] reported on a new method of producing heat in tissues, the "inductotherm." They concluded that electromagnetic induction had heating characteristics such that heating would be produced in the more conductive or more vascular tissues rather than in the less conductive or more adipose tissues. Holmquest and Marshall[2] reported that electromagnetic induction was an effective, highly efficient and convenient method of heating tissues.

In 1935 Mortimer and Osborne,[3] by measuring the average rises in temperature in the quadriceps muscle of 8 human subjects, showed that the induction method of heating was an efficient method superior to other forms of diathermy. Continuing this work and using the same technic, Mortimer

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 9, 1948.

* Abridgment of thesis submitted by Dr. Rae to the Faculty of the Graduate School of the University of Minnesota in partial fulfilment of the requirements for the degree of Master of Science in Physical Medicine.

1. Merriman, J. R.; Holmquest, H. J., and Osborne, S. L.: A New Method of Producing Heat in Tissue: The Inductotherm, Am. J. M. Sc. **187**:677 (May) 1934.

2. Holmquest, H. J., and Marshall, J. G.: Inductothermy: Its Physical Basis and Technique Application, Brit. J. Phys. Med. **11**:70 (Aug.) 1936.

3. Mortimer, Bernard, and Osborne, S. L.: Tissue Heating by Short Wave Diathermy: Some Biologic Observations, J. A. M. A. **104**:1413 (April 20) 1935.

and Beard[4] tested additional short wave diathermy machines, making a total of fourteen machines that were tested by these two groups of workers. The wavelengths ranged from 6 to 25 meters. They concluded that there was no advantage of any one wavelength over another for heating purposes. Coulter[5] reported that the relative efficiency of methods of application in short wave diathermy were in the following order: (1) cable and coil, or double cuffs; (2) electric field electrodes, and (3) glass or composition, air-separated electrodes.

In a study in pelvic heating by five short wave machines, Coulter and Osborne[6] made twenty-nine observations on 9 subjects. They found that the maximal temperature was reached in less than twenty minutes and stated that the maximal temperature apparently was attained when the rate of generation of heat and rate of dissipation of heat by the circulating blood were equalized. They found that in short wave diathermy the electromagnetic field produced the highest temperature with the most comfort. They were of the opinion that, as a standard of comparison, the final temperature attained was of far greater significance than the mere temperature increment. Coulter and Carter[7] came to the same conclusions.

Preliminary work demonstrated that microwaves could heat living tissues to a depth of at least 3 cm.[8] A definite increase in blood flow in the heated area accompanied the rise in temperature of the tissues exposed to microwaves.

Osborne and Frederick[9] have reported on the heating of human and animal tissues by means of microwave radiations. The thigh of the dog was subjected to the high frequency energy, and temperatures were taken in the subcutaneous tissue and at a depth of ½, 1, 1½ and 2 inches (1.27, 2.54, 3.81 and 5.08 cm.) from the surface. The entire procedure was completed within one and one-half minutes after the heating was stopped. They observed that the maximal temperature was in the subcutaneous tissues and decreasing temperatures occurred with increasing depth. In addition, the thigh of human subjects was exposed to microwave energy and temperatures averaging 104.2 F. (40.1 C.) were recorded at a depth of approximately 2 inches.

Apparatus Tested

The microwave generator which we used in our work is a small portable unit called the "microtherm." It supplies continuous microwave energy at a frequency of 2,450 megacycles per second, corresponding to a wavelength of about 12 cm. The maximal power output of this machine is 125 watts. The energy is generated in a continuous wave magnetron oscillator tube and transported to the director by a coaxial cable.

At present the apparatus includes three directors: director A (a 4 inch hemispheric type), director B (a 6 inch hemispheric type) and director C (a corner reflector type). Each director has a different pattern for surface heat.[10] The circular pattern produced by director A is seen in chart 1. The peak, or the 100 per cent area of heating, is toward the periphery and not in the center of the pattern. Chart 2 shows the surface heating pattern of director B, the larger of the two hemispheric directors. It is the same type

4. Mortimer, Bernard, and Beard, Gertrude: Tissue Heating by Short Wave Diathermy, J. A. M. A. **105**:510 (Aug. 17) 1935.
5. Coulter, J. S.: Medical Diathermy, J. A. M. A. **106**:209 (Jan. 18) 1936.
6. Coulter, J. S., and Osborne, S. L.: Short Wave Diathermy: Comparative Study in Pelvic Heating, Arch. Phys. Therapy **17**:135 (March) 1936.
7. Coulter, J. S., and Carter, H. A.: Heating of Human Tissues by Short Wave Diathermy, J. A. M. A. **106**:2063 (June 13) 1936.
8. Krusen, F. H.; Herrick, J. F.; Leden, Ursula, and Wakim, K. G.: Microkymatotherapy: Preliminary Report of Experimental Studies of the Heating Effect of Microwaves ("Radar") in Living Tissues, Proc. Staff Meet., Mayo Clin. **22**:209 (May 28) 1947; Leden, Ursula M.; Herrick, J. F.; Wakim, K. G., and Krusen, F. H.: Preliminary Studies on the Heating and Circulatory Effect of Micro-Waves—"Radar," Brit. J. Phys. Med. **10**:177 (Nov.-Dec.) 1947.
9. Osborne, S. L., and Frederick, J. N.: Microwave Radiations: Heating of Human and Animal Tissues by Means of High Frequency Current with Wavelength of Twelve Centimeters (the Microtherm), J. A. M. A. **137**:1026 (July 17) 1948.
10. The Microtherm Operating Manual, Waltham, Mass., Raytheon Manufacturing Co., 1947.

of pattern as director A, only larger. The energy pattern for director C varies from the preceding two (chart 3). The heating reaches a maximum at the center of an oval pattern. All these patterns were taken in dead tissue and do not reflect the equalizing effect of the circulation in living tissue. Only directors A and C were used in this study.

Four short wave diathermy machines (machines 1, 2, 3 and 4) were tested. These machines are all products of reputable firms and in wide use clinically at present. The wavelengths varied from 6 to 25 meters.

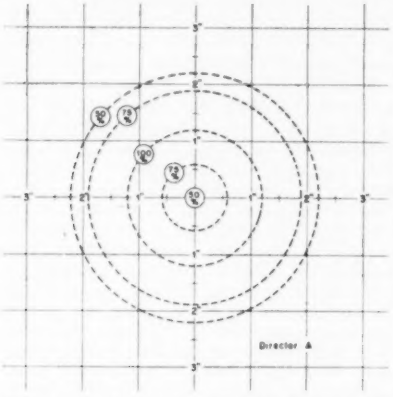

Chart 1. — Surface heating pattern in dead tissue for director A at a distance of 1 inch (2.54 cm.) from the skin.

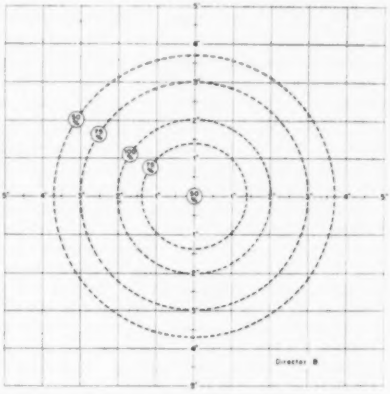

Chart 2. — Surface heating pattern in dead tissue for director B at a distance of 2 inches (5.08 cm.) from the skin.

Method

The method of measurement of local temperatures is not entirely satisfactory. It would be desirable to take temperatures while the tissues are being heated, but this is not possible when thermocouples are used. Use of thermocouples before and after exposure to the high frequency waves is a technic which is approved by the Council on Physical Medicine of the American Medical Association. In our studies three

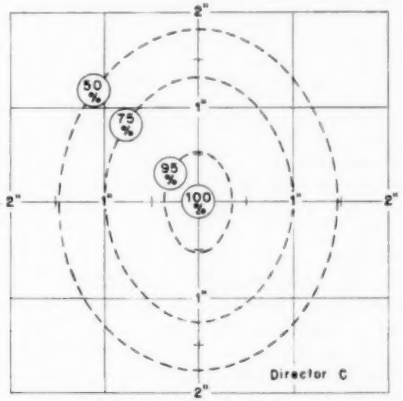

Chart 3. — Surface heating pattern in dead tissue for director C at a distance of 2 inches (5.08 cm.) from the skin.

needle thermocouples were inserted, one into the subcutaneous layer and two into the muscle, one at a depth of 1.5 cm. and the other at a depth of 3 cm. These two depths will sometimes be referred to in this paper as superficial and deep muscle, respectively. Skin temperatures were taken with a thermistor. Temperatures were recorded on a

moving photographic film. Calibration tests indicated that the thermocouples and the thermistor recorded temperatures within an experimental error of ±0.2 degrees C. The calibrations were carried out at frequent intervals with a Bureau of Standards calibrated thermometer with scale divisions in 0.1 degree C.

Four intact dogs were used in this study. They were well trained and in the fasting state. Basal conditions were approached by permitting the dog to lie quietly on the table for thirty minutes or longer before any measurements were taken. The thigh was chosen as the site of application, as this is the area where sufficient tissues are available in the dog. The thigh was kept free of hair by frequent clipping.

A total of 144 experiments were performed with the four short wave diathermy machines and two microwave directors (A and C) as follows: Twenty-four experiments were carried out with each type of apparatus. These 24 experiments consisted of 6 experiments on each of the 4 dogs. The 6 experiments consisted of 2 at each of the three periods of radiation — that is, for ten, twenty and thirty minutes.

Since the literature[11] and clinical practice so clearly indicated that the coil or cable technic of induction with short wave diathermy was the most effective method of producing heat in the depths of living tissue, we employed this technic to the exclusion of all other methods of short wave diathermy. The method of application was that used in clinical practice and conformed with the recommendations of the manufacturers. Four complete turns of the cable were applied around the thigh of the dog with the site of insertion of the thermocouples as near as possible to the midpoint between the extremities of the coil. As usual, dosage presented a problem. Clinically the dosage is governed by the sensation of heat felt by the human patient. For the experimental animal we used what we considered to be an average clinical dose. With two of the diathermy machines we found that full output was needed due to the small load furnished by the animal. In order to find a dose which the dog would tolerate, a considerable number of scouting experiments were performed with the other two short wave diathermy machines. In these various attempts we aimed at duplicating as closely as possible the clinical technic of application.

With microwaves the application was considerably easier. When the 4 inch (10.2 cm.) hemispheric director A was used, the distance from the surface of the director to the skin was 1 inch (2.5 cm.), while with director C, the corner type, the distance was 2 inches (5.1 cm.). The plate current was set and maintained at 60 ma., which corresponds to approximately 47.5 watts. The distance of the director from the skin was measured accurately, and the output of the machine was controlled carefully.

Careful technic was necessary for obtaining accurate temperatures. The thermocouple needles were inserted in a marked area on the lateral aspect of the thigh; the thermistor was placed on the skin surface, and control temperatures were taken. The needles and the thermistor were then removed from the field during the application of the high frequency current. Immediately after the treatment, the needles were reinserted in the marked area and the thermistor reapplied to the skin. Temperature readings were obtained exactly thirty seconds after turning off the generator. Following heating with microwaves, the temperatures were taken from the zone of maximal concentration in the surface heat pattern. After each experiment a cooling period of forty-five to sixty minutes was allowed even though the temperatures returned to control levels within thirty minutes.

Rectal temperatures were taken before and after each period of heating.

Results

The data obtained on testing four short wave diathermy machines are presented in table 1. Each of the figures represents the average of eight determinations on four dogs. The data recorded in table 2 represent an average of the temperatures measured when short wave machines 1, 2 and 3 were used and the average temperatures recorded when microwave directors A and C were used. The data obtained on the use of short wave machine 4 were not included in the average of the other short wave machines because the apparatus was designed with a discontinuous cable. Although the technic used was the same—namely, four turns of the cable around the dog's thigh — the method of heating with machine 4 could not properly be termed "induction" because of this discontinuity.

11. Footnotes 1, 2, 3, 5, 6 and 7.

The averages for the control temperatures before diathermy at any one site of measurement were remarkably close (table 2). The average temperature range for the skin is 36.0 to 36.5 C., with an over-all average of 36.2 C. The average range for the subcutaneous temperature is from 36.2 to 36.6 C., with an over-all average of 36.5 C. In the superficial muscle (1.5 cm. in depth) the control temperature ranged from 37.2 to 37.4 C., with an over-all average of 37.3 C., while that of the deep muscle (3 cm. in depth) ranged from 37.5 to 37.8 C., with an over-all average of 37.6 C. These averages of control temperatures definitely show that normally the temperature gradient is outward from the warmer muscle to the less warm subcutaneous

TABLE 1. — *Average Temperatures in Degrees Centigrade in the Thigh of the Intact Dog Before and After Short Wave Diathermy*

Short Wave Machine	Radiation, Min.	Skin		Subcutaneous Tissue		Muscle — 1.5 Cm. Depth		Muscle — 3 Cm. Depth	
		Before	After	Before	After	Before	After	Before	After
1	10	36.6	39.1	36.6	39.5	37.4	40.1	37.4	38.4
	20	36.3	39.1	36.4	39.7	37.3	41.0	37.5	39.5
	30	36.4	39.6	36.6	39.7	37.2	40.6	37.4	39.7
2	10	36.7	38.8	37.0	39.8	37.6	40.5	37.8	37.7
	20	37.0	39.7	37.2	41.0	37.7	41.7	38.0	39.0
	30	36.7	39.4	36.9	40.8	37.6	41.9	37.8	39.5
3	10	36.2	38.3	36.1	39.6	37.1	40.0	37.4	38.3
	20	36.3	38.2	36.2	39.7	37.2	40.7	37.4	39.5
	30	36.0	38.6	35.9	40.1	37.0	40.9	37.2	39.7
4	10	35.8	37.0	35.8	37.2	37.1	37.7	37.4	37.6
	20	36.0	38.2	35.8	38.4	37.2	39.0	37.5	38.4
	30	35.9	37.9	36.0	38.7	37.4	39.4	37.6	38.8

tissues and skin. We believe that the small range of temperature seen in the control observations is further evidence of the reliability of the method of measuring temperatures.

The averages of the actual temperature attained with short wave and microwave diathermy are shown in table 2, and the average increases of

TABLE 2. — *Average Temperatures in Degrees Centigrade in the Thigh of the Intact Dog Before and After Short Wave and Microwave Diathermy.*

Apparatus	Radiation, Min.	Skin		Subcutaneous Tissue		Muscle — 1.5 Cm. Depth		Muscle — 3 Cm. Depth	
		Before	After	Before	After	Before	After	Before	After
Average for short wave machines 1, 2 and 3	10	36.5	38.7	36.6	39.6	37.4	40.2	37.5	38.1
	20	36.5	39.0	36.6	40.1	37.4	41.1	37.6	39.3
	30	36.4	39.2	36.5	40.2	37.3	41.1	37.5	39.6
Microwave director A	10	36.0	38.1	36.5	39.6	37.4	40.2	37.8	38.9
	20	36.0	38.4	36.5	39.9	37.3	41.2	37.7	39.9
	30	36.1	38.0	36.4	39.5	37.3	40.1	37.7	40.0
Microwave director C	10	36.0	40.8	36.2	42.0	37.2	43.6	37.5	40.2
	20	36.2	39.4	36.3	40.4	37.2	41.5	37.5	41.1
	30	36.2	38.4	36.5	39.7	37.3	41.0	37.5	39.8

temperature after heating with each of the four short wave machines are shown in table 3. Table 4 gives the average of the results shown in table 3 excluding machine 4 but including the average rises in temperature obtained with microwave directors A and C.

Charts 4, 5 and 6 present the data in tables 2 and 4 in graphic form. These graphs reveal rather strikingly not only that the temperature decreases from within out to the cool skin before heating but that in all cases after heating this relationship still holds from the superficial muscle layers to the

skin. However, if the deeper muscle layers are taken into consideration, the gradient is reversed. When charts 4, 5 and 6 are compared, it immediately becomes apparent that director C produced the highest temperatures. When this comparison is carried a little further, it can be seen that short wave diathermy produced its highest temperatures after thirty minutes of treatment; director A, its highest temperatures after exposures for twenty minutes, and director C, its highest temperatures in the tissues after ten minutes of exposure. It also can be seen in charts 4, 5 and 6 that the tem-

TABLE 3. — *Average Increase of Temperature in Degrees Centigrade in the Thigh of the Intact Dog After Short Wave Diathermy.*

Short Wave Machine	Radiation, Min.	Skin	Subcutaneous Tissue	Muscle	
				1.5 Cm. Depth	3 Cm. Depth
1	10	2.5	2.9	2.7	1.0
	20	2.8	3.3	3.7	2.0
	30	3.2	3.1	3.4	2.3
2	10	2.1	2.8	2.9	—0.1
	20	2.7	3.8	4.0	1.0
	30	2.7	3.9	4.3	1.7
3	10	2.1	3.5	2.9	0.9
	20	1.9	3.5	3.5	2.1
	30	2.6	4.2	3.9	2.5
4	10	1.2	1.4	0.6	0.2
	20	2.2	2.6	1.8	0.9
	30	2.0	2.7	2.0	1.2

TABLE 4. — *Average Increase of Temperature in Degrees Centigrade in the Thigh of the Intact Dog After Short Wave and Microwave Diathermy.*

Apparatus	Radiation, Min.	Skin	Subcutaneous Tissue	Muscle	
				1.5 Cm. Depth	3 Cm. Depth
Average for short wave machines 1, 2 and 3	10	2.2	3.0	2.8	0.6
	20	2.5	3.5	3.7	1.7
	30	2.8	3.7	3.8	2.1
Microwave director A	10	2.1	3.1	2.8	1.1
	20	2.4	3.4	3.9	2.2
	30	1.9	3.1	2.8	2.3
Microwave director C	10	4.8	5.8	6.4	2.7
	20	3.2	4.1	4.3	3.6
	30	2.2	3.2	3.7	2.3

peratures produced by application of microwaves with director A, at the dosage we used, were not much different from the temperatures produced by short wave diathermy. After ten minutes of heating with short wave diathermy, the average rise in temperature of the deep muscle (3 cm. depth) was 0.6 degree C., and after a similar period of heating with microwave director A, the rise produced in the deep muscle was 1.1 degree C. After twenty minutes of heating, the average rises in the deep muscle were 1.7 degree C. for the short wave machines and 2.2 degree C. for director A. After thirty minutes of heating with the short wave machines, the rise in the deep muscle was 2.1 degree C., while with director A, the rise in the same muscle was 2.3 degree C. It would appear that short wave generators lag behind microwaves in getting heat into the deeper tissues, but with the methods used in this study approximately the same temperatures are reached in the deeper tissues after thirty minutes of heating with both types of generators. Short wave machines 1 and 3 produced nearly as high temperatures in the deep tissues as did microwave director A. Short wave machine 2 did not seem to heat the deep muscle layer as well as the other generators. The

low temperatures recorded when this generator was used lowered the overall average of the deep muscle temperature for the short wave machines.

Of all the generators tested microwave director C obviously produced the highest temperature in the tissues (chart 6). The energy developed by this

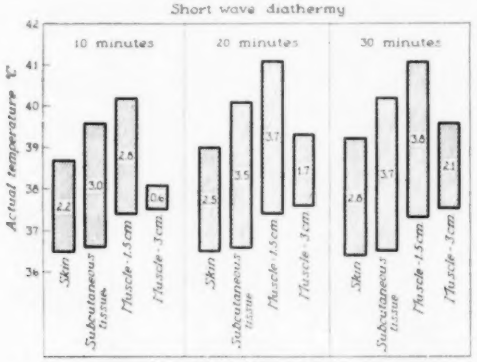

Chart 4. — Average changes following short wave diathermy for ten, twenty and thirty minutes: averages obtained from use of short wave machines 1, 2 and 3. Numbers in center of columns indicate temperature rises in degrees C. The bases of the columns represent average control temperature before heating. The tops of columns represent average final temperatures.

director is concentrated in the center of a small heating pattern. The same amount of energy generated by the machine was transferred to the tissues with either director A or C, but since the energy transmitted by director C is concentrated into a smaller area higher temperatures developed in the tissues.

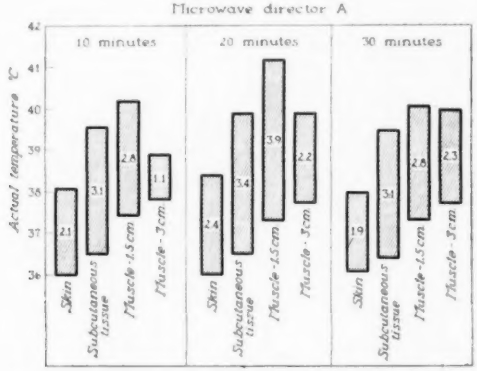

Chart 5. — Average changes following microwave diathermy for ten, twenty and thirty minutes: averages obtained from use of director A. Numbers in center of columns indicate temperature rises in degrees C. The bases of columns represent average control temperature before heating. The tops of columns represent average final temperatures.

Chart 7 shows the average temperatures for the three different periods of radiation (ten, twenty and thirty minutes) obtained in the skin, subcutaneous tissues, superficial muscle and deep muscle when the short wave diathermy and microwave directors A and C, respectively, were used. Chart

7a shows that short wave diathermy produces the highest average temperatures after thirty minutes of heating. However, there is very little more heating after thirty minutes of radiation than there is after twenty minutes. Chart *7b* reveals that the highest temperatures were observed in the skin,

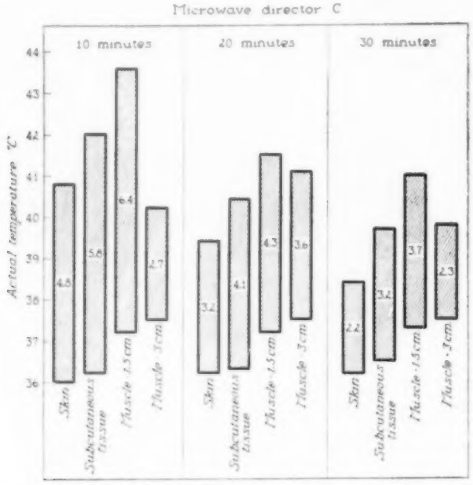

Chart 6. — Average changes following microwave diathermy for ten, twenty and thirty minutes: averages obtained from use of director C. Numbers in center of columns indicate temperature rises in degrees C. The bases of columns represent average control temperature before heating. The tops of columns represent average final temperatures.

subcutaneous and superficial muscle layers after twenty minutes of radiation with director A. The temperatures observed at these three sites were not so high after exposure for thirty minutes as after exposure for twenty minutes. The temperature of the deep muscle, however, remained approximately the same after thirty minutes as after twenty minutes of application.

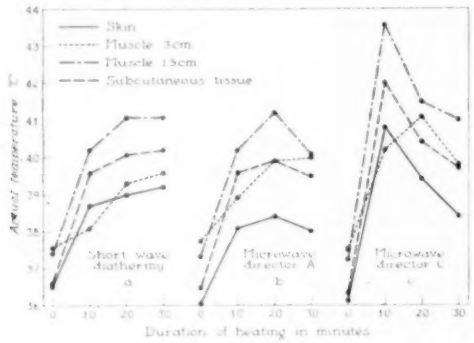

Chart 7. — Variations in temperature after ten, twenty and thirty minutes of heating. *a*, With short wave diathermy; *b*, with microwave director A; *c*, with microwave director C.

A comparison of the curves in chart *7a* and *b* indicates that, after heating for twenty minutes, similar temperatures developed in the tissues after

use of either the short wave diathermy machines or microwave director A. Although the tissues were heated to approximately the same levels with either type of apparatus, no drop in the temperatures occurred after exposure for thirty minutes to short wave diathermy.

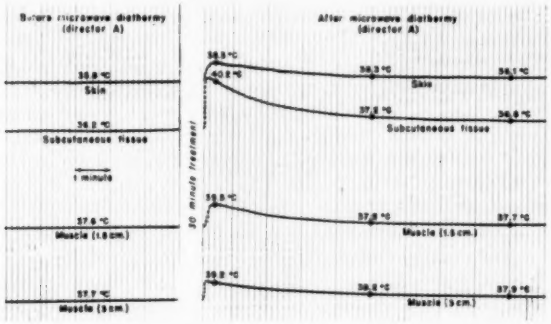

Chart 8. — Retouched photographic record of control temperatures and of cooling curves after thirty minutes of heating with microwave director A.

Chart *7c* clearly demonstrates that director C develops the highest temperatures in the skin, subcutaneous and superficial muscle layers after ten minutes of heating. Temperatures in the same sites were considerably lower after twenty minutes of exposure and still lower after thirty minutes of radiation. The temperature of the deep muscle reached its highest level after twenty minutes of heating.

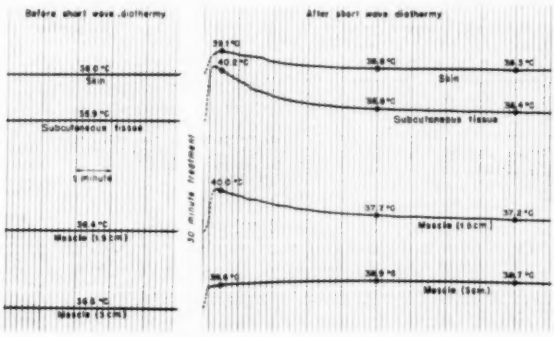

Chart 9. — Retouched photographic record of control temperatures and of cooling curves after thirty minutes of heating with short wave diathermy.

Charts 8 and 9 are photographs of representative "cooling curves" of the tissues after application of microwave director A and short wave diathermy. These curves show that the subcutaneous tissues cooled more rapidly than the skin. Chart 8 reveals that when microwaves were applied the deeper muscle layers cooled more slowly than the skin and subcutaneous layers. However, chart 9 shows that the so-called cooling period after application of short wave diathermy was not accompanied with cooling of the deep muscle layer until a variable number of minutes had elapsed from the time of turning off the generator. The time necessary for the temperature of the deep muscle layer to level off and gradually cool depended on the period of

exposure to the short wave generators. The longer the treatment, the quicker the deep muscle would start to cool.

The relationship of the temperature of the deep muscle to the subcutaneous temperature after heating with the various types of generators is illustrated in chart 10. The relationship between temperatures of deep muscle and subcutaneous tissues after microwave diathermy was different from that after short wave diathermy.

The application of microwaves at the dosage we used produced no significant change in rectal temperature in the animal while short wave diathermy produced an average rise of 0.5 degree C.

Comment

The temperature of any tissue depends on the relationship between the factors which contribute or add heat to the tissue and the factors which

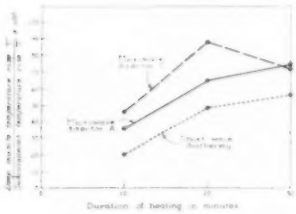

Chart 10. — Relationship between the increase in the temperature of deep muscles and that of subcutaneous tissues after ten, twenty and thirty minutes of heating. Values shown represent ratio of rise in deep muscle to rise in subcutaneous tissues × 100. All increases in temperature of deep muscles were less than in those in subcutaneous tissue. A value of 100 would indicate a rise equal to that in subcutaneous tissue.

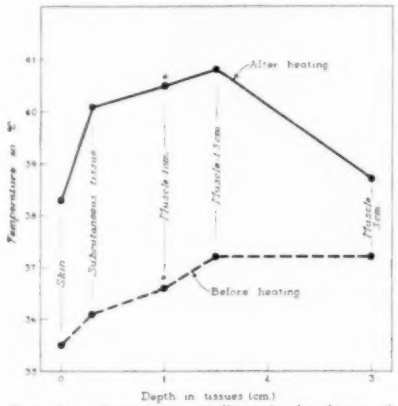

Chart 11. — Temperature gradients in the tissues of trained dogs before and after exposure to microwaves for twenty minutes at a distance of 1 inch (2.5 cm.) and a power output of 47.5 watts. Each point on the curves represents the average of 26 observations, except the one with the asterisk, which represents only 18.

carry away or dissipate heat from that region. When the amount of heat produced is equal to that dissipated, a dynamic equilibrium is established, and a constant temperature is maintained in the area as long as this stable relationship exists. Before heating, the deeper muscle layers were the warmest, and the more superficial the layer of tissue, the cooler it was. The depth of a tissue from the surface is one of the important factors in determining the temperature of that tissue. In addition to metabolic factors, the proximity of the skin and subcutaneous tissues to a cooler environment gives them a lower temperature than muscle. Heat is more readily dissipated from superficial areas because of the more favorable position.

A clear concept of the temperature gradient in tissues after heating is desirable. We believe that the temperature gradient should be closely correlated with the depth at which measurements of temperature are made. It is possible to obtain two diametrically opposite temperature gradients depending on the depths at which the temperatures are taken. Chart 11 illustrates how these two entirely different gradients may be obtained. Simultaneous recording of the temperatures of the skin, subcutaneous tissue in the

loose area beneath the skin and the superficial layer of muscle following microwave radiation gave a gradient from the cooler skin to the warmer (superficial) muscle underneath. On the other hand, temperatures taken in muscle tissue showed that a gradient is obtained from the warmer superficial muscle layers to the cooler deep muscle tissue. Obviously the direction of the temperature gradient depends on the level or depth from which the comparative temperatures are determined.

In order to be able to compare accurately the temperatures produced in tissues at various depths, it is absolutely imperative that these temperatures be recorded simultaneously. Furthermore, it is essential to keep in mind that the rates of cooling of the various tissues after heating is not the same. Therefore, the comparative relationship of the temperatures of tissues at different depths may vary in the first thirty seconds after heating, but according to our observations this difference is not significant enough to alter the gradient in that short time.

To determine the time required for the needle thermocouples and thermistor to come to equilibrium and to obtain simultaneous records of the temperatures of the tissues at various depths, the reflections of the galvanometers were recorded continuously on a moving camera film. For determination of the temperature gradient, simultaneous readings were made in the various tissues exactly thirty seconds after the heating was stopped.

The duration of exposure of the area, the output of the machine and the distance between the source transmitting the energy and the surface of the body are additional factors which influence the temperature gradient of heated tissues. These factors must be included among those previously discussed in the establishment of temperature gradients.

An analysis of the data in table 1 reveals that there is considerable variation in the heating produced by the different short wave machines tested. Similar variations were noted by Coulter and his associates. Among the important factors causing these variations in temperature are differences in the output of the machines, the amount of energy delivered to the subject and the technic of application. Furthermore, the degree of heating varied in the different animals used. In some of the animals the tissues heated better than in others and did so consistently no matter which generator was used. Short wave machine 4 heated the tissues the least, and yet the dogs appeared to be less comfortable when this generator was applied and they would not tolerate a higher output. This suggests that the sensation of temperature experienced by the subject does not necessarily indicate the amount of heat being developed in the deeper tissues.

A comparison of microwave diathermy with short wave diathermy is difficult because of the great difference in the size of the heating pattern and the amount of tissue heated. With short waves a much larger amount of tissue is heated than with microwaves. If the pattern and amount of tissue heated were the same, would the temperature produced in the deeper tissues by microwaves be definitely higher than that developed by short waves? Some of us are already investigating this problem. However, with the technic and dosage used in this part of the investigation, we have observed no significant difference between the temperatures developed in various layers of living tissues by microwave director A and by some short wave generators.

One important observation was that with microwave director A higher temperatures were obtained after twenty minutes than after thirty minutes of treatment. This same observation has been made when human subjects

were used.[12] Previous studies have shown that with microwave director A an increase in the circulation occurs and reaches significant levels at about twenty minutes of heating. The increased circulation carries away more of the heat. This phenomenon of lower temperatures after thirty minutes than after twenty minutes of heating with microwaves did not appear when short waves were used. We believe that the lower temperatures obtained after thirty minutes of heating as compared with twenty minutes do not occur when short wave diathermy is used because of the larger amount of tissue heated by this apparatus. The increase in the circulation with short wave diathermy may be as great as, or even greater than, with microwaves, but it may still be inadequate to lower the temperatures because of the much larger mass of tissue that is heated by the short wave diathermy machine.

After exposure to short wave diathermy was discontinued, the temperature of the deep muscle (3 cm. depth) rose for a variable number of minutes. Instead of decreasing as expected, there was an increase. It is probable that the amount of tissue heated by the short wave generators plays a significant role in producing the peculiar cooling curve of the deep muscle. With the coil technic of application, the entire thigh of the dog is heated. Our data definitely indicate that at the end of the heating period the superficial muscle layer has reached a higher temperature than the adjacent deeper muscle layer. It is conceivable that the larger mass of superficial tissue heated when short wave generators are used could cause more heat to be transferred into the deep muscle and produce a transient rise in its temperature.

The relationship between increases of temperature in deep muscle and subcutaneous tissues was different after microwave diathermy from that after short wave diathermy. In all cases the increase in temperature of the subcutaneous tissues was greater than that of the deep muscle. However, after heating with microwaves, the increase in temperature of the deep muscle more nearly approached that of the subcutaneous tissues than when short wave diathermy was used (chart 10). In the treatment of certain clinical entities this relationship may prove desirable.

When the heating was produced by microwaves, there was no significant change in the rectal temperature. However, when the heating was produced by short waves, there was an average rise of 0.5 degree C. in rectal temperature. It must be remembered that the rectum in the dog is close to the electromagnetic field of the diathermy coil surrounding the thigh. At least a part of this rise in rectal temperature can be attributed to the direct effect of the electromagnetic field on this area.

Summary

A comparison was made of the temperatures produced in the tissues of trained dogs by four short wave diathermy machines and two microwave directors. Temperatures were measured by means of a thermistor and needle thermocouples and were recorded on a moving photographic film. Temperatures were determined after ten, twenty and thirty minutes of radiation.

The following observations were made:

1. Before heating, the temperature gradient was from within outward — that is, from the warmer muscle to the less warm subcutaneous tissues and skin.

2. After heating with microwave or short wave diathermy, this temperature gradient remained the same; from the superficial muscle layers to

12. Gersten, J. W.; Wakim, K. G.; Herrick, J. F., and Krusen, F. H.: The Effects of Microwave Diathermy on the Peripheral Circulation and on Tissue Temperature in Man, Arch. Phys. Med. 30:7 (Jan.) 1949.

the skin. However, in muscles the gradient was reversed; from the warmer superficial layers to the less warm deeper layers.

3. There was considerable variation in the temperatures produced by the different short wave generators.

4. With the technics and dosages used in this study, the differences between the temperatures produced in the deep tissues by microwave director A and by some short wave generators were not significant.

5. Higher temperatures were obtained after twenty minutes of heating with microwave director A than after thirty minutes of such treatment. This phenomenon was not seen when short wave generators were used.

6. Immediately after short wave diathermy, the temperatures of the deep muscle (3 cm. in depth) rose for a variable number of minutes. This phenomenon was not observed after treatment with microwaves.

7. The ratio of the increase of temperature in the deep muscles to that in subcutaneous tissues was higher after microwave than after short wave diathermy.

Discussion

Dr. Frederic T. Jung (Chicago): This paper exemplifies the advantages of comparative studies, in that the contact between two forms of apparatus has a more evident significance than would the data from a single device.

The two mysteries uncovered by this work should encourage further investigation. One is the apparent adaptation of the organism to the continued influence of microwaves during the course of a treatment, as compared with the sustained nature of the temperature rise produced by the short wave diathermy. The other is the continuation of the temperature rise after the discontinuation of the short wave diathermy. If the explanation turns out to be a difference in vascular effects, this should be studied more closely in order to see whether the difference can be turned to account.

Existing differences of opinion as to the meaning of observed temperature gradients and as to the genuineness of the reported differences in temperature gradients may be the result of making studies on heterogeneous structures. It is possible that more concordant results might be obtained from studies on large, relatively homogeneous masses like the liver.

WESTERN SECTION MEETING

The Western Section of the American Congress of Physical Medicine will meet in Los Angeles on May 5, 1949, immediately preceding the meeting of the California Medical Association at the Biltmore Hotel. An afternoon and evening program is being prepared. The details of the program are not complete, but those interested may write to the Secretary for further information. Open to members of the regular medical profession and properly sponsored registered physical therapists. Fred B. Moor, M.D., Secretary, Western Section.

EFFECTS OF WHIRLPOOL BATH WITH AND WITHOUT AGITATION ON THE CIRCULATION IN NORMAL AND DISEASED EXTREMITIES *

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Whirlpool bath therapy has been used extensively in medical and surgical conditions since its origin in French military hospitals during the first World War. Since then, various claims concerning the clinical efficacy of agitation of the warm water have been advanced[1]: that it increases the heating effectiveness; improves the circulation; has a cleansing effect; produces the effects of light massage, with resultant decrease of pain and muscle tightness, and encourages active movement of the part. On an empirical basis the recommended temperatures for treatment have varied widely, from 33 to 46 C., among various workers in the field of hydrotherapy, — depending in part on the pathologic conditions under consideration. Although experimental and clinical data have been reported concerning the effect of hot water immersion baths on blood flow, few, if any, data are available relative to the effect of agitation of the water.

The variables involved in an evaluation of whirlpool bath therapy include (1) temperature of the water, (2) duration of treatment, (3) force of agitation, (4) extent of immersion of the extremity (or body), (5) position of the part involved (dependent or horizontal, supported or unsupported), (6) activity of the treated extremity within the bath and (7) condition of the part undergoing treatment. This study was performed in order to determine the effect of the whirlpool bath with and without agitation on blood flow in the forearm, including the hand, of normal and diseased extremities.

Method

This study was made on 20 men between 16 and 48 years of age. They were grouped as follows: Group 1 consisted of 11 subjects who had normal upper extremities; group 2 included 5 subjects who had varying degrees of flaccidity of the upper extremities; group 3 was composed of 4 subjects who had atrophic upper extremities. The atrophy was due in 1 case to disuse following a fracture and in 3 cases to rheumatoid arthritis.

All observations were made in a room free from drafts with a temperature around 80 F., which did not vary significantly during the observations. Each of the subjects was comfortably clothed and was seated on a chair for

* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 11, 1948.

1. Nylin, J. B.: Hydrotherapy, in Principles and Practice of Physical Therapy, edited by H. E. Mock; R. Pemberton, and J. S. Coulter, Hagerstown, Md., W. F. Prior Company, Inc., 1935, vol. 3, chap. 29, p. 47. Ewerhardt, F. H.: Use of Heat and Cold, ibid. vol. 3, chap. 2, p. 6. Pollack, L. J.: Peripheral Nerve Lesions, ibid. vol. 2, chap. 7, p. 28. Krusen, F. H.: Physical Medicine, Philadelphia, W. B. Saunders Company, 1941.

thirty minutes before control blood flow determinations were made. During this period the upper extremities were enclosed up to 1 inch (2.5 cm.) above the olecranon process in venous occlusion plethysmographs, with a compensating spirometer recorder, which was used for the blood flow determinations as described by Berry and associates.[2] After the control blood flow was established on both upper extremities, the subject was taken to the whirlpool bath. The cuffs were left in place on the arms. On the immersed limb oiled silk was wrapped over the cuff to keep it dry. The subject was seated at the side of the bath opposite the agitator, which was directed toward the forearm at a 90 degree angle. The forearm was suspended unsupported in the water up to the elbow. There was no voluntary activity of the immersed part. The rim of the bath was padded to avoid interference with the circulation.

The whirlpool bath used was a standard commercial model with a 1/3 horsepower motor for air intake and agitation. Approximately 20,000 cubic inches of air per minute was mixed with the water. This air was preheated by passage over the motor. The water was circulated by means of a turbine at a rate of 45 gallons per minute. The immersion was done at 39.0 C. (102.2 F.) for thirty minutes in 15 subjects; in 5 subjects higher temperatures (41.0 to 42.5 C.) were used. The cooling of the water during agitation averaged 0.8 degree C. (1.4 degree F.); without agitation the water temperature decreased 0.7 degree C. (1.2 degree F.). Thus the average temperature of the water in the bath with agitation was 38.6 C. (101.5 F.); without agitation it was 38.7 C. (101.6 F.).

Each subject was given two treatments, identical in all respects except that one procedure included agitation and the other was done without agitation of the water in the whirlpool bath.

After the treatment, the extremity was dried with a bath towel without rubbing, the oiled silk was removed and the plethysmographs were reapplied to the upper extremities as in the control observations. Determinations of the blood flow in both the treated and the untreated extremities were made at five, fifteen and forty-five minute intervals after removal of the extremity from the whirlpool bath.

Results

The control blood flow in 7 normal upper extremities before immersion into the whirlpool bath averaged 122 cc. per minute (6.7 cc. per hundred cubic centimeters of tissue per minute) with a range from 72 to 164 cc. per minute. After immersion in the bath for thirty minutes at 38.6 C. with agitation, the average blood flow in the 7 normal extremities was 139 cc. per minute (7.7 cc. per hundred cubic centimeters of tissue per minute) with a range from 98 to 204 cc. per minute. This represents an average increase in flow of 17 cc. per minute or, 14 per cent (range —20 to +67 per cent). Table 1 gives the data on the individual subjects.

In the contralateral untreated upper extremity the average blood flow decreased from 127 cc. per minute (control value) to 121 cc. per minute, an average decrease of 6 cc. per minute, or 5 per cent.

The control blood flow in the 7 normal upper extremities before immersion averaged 104 cc. per minute (5.7 cc. per hundred cubic centimeters of tissue per minute), with a range from 80 to 181 cc. per minute. After immersion in the bath for thirty minutes at 38.6 C. without agitation, the average blood flow was 134 cc. per minute (7.4 cc. per hundred cubic centimeters

2. Berry, M. R.; Baldes, E. J.; Essex, H. E., and Wakim, K. G.: A Compensating Plethysmokymograph for Measuring Blood Flow in Human Extremities, J. Lab. & Clin. Med. 33:101-117 (Jan.) 1948.

of tissue per minute), with a range from 110 to 174 cc. per minute. This represents an average increase of 30 cc. per minute, or 29 per cent (range —24 to +91 per cent).

In the contralateral untreated upper extremity the average blood flow increased from 131 cc. per minute (control value) to 142 cc. per minute, an average increase of 11 cc. per minute, or 8 per cent.

The control blood flow in 5 extremities with varying degrees of flaccidity averaged 83 cc. per minute (5.6 cc. per hundred cubic centimeters of tissue per minute) before immersion in the whirlpool bath, with a range from 30 to 140 cc. per minute. After immersion in the bath for thirty minutes at 38.6 C. with agitation, the average blood flow in the 5 extremities was 134 cc. per minute (9.0 cc. per hundred cubic centimeters of tissue per minute), with a range from 66 to 200 cc. per minute. This represents an average increase in flow of 51 cc. per minute, or 61 per cent (range —17 to +120 per cent).

Table 1. — *Blood Flow in Upper Extremities Before and After Immersion in a Whirlpool Bath for 30 Minutes at 38.6 C.*

		With Agitation						Without Agitation					
		Before Immersion		5 Min. After Immersion		Difference		Before Immersion		5 Min. After Immersion		Difference	
Subject	Condition of Extremity	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Per Cent	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Per Cent
3	Normal	118	7.4	185	11.6	+67	+57	87	5.4	129	8.0	+42	+48
4	Normal	122	7.2	98	5.8	—24	—20	98	5.8	135	8.0	+37	+38
5	Normal	164	8.2	150	7.5	—14	—9	98	4.9	118	5.9	+20	+20
6	Normal	155	8.6	125	7.0	—30	—19	181	10.0	137	7.6	—44	—24
7	Normal	72	3.7	98	5.0	+26	+36	91	4.7	174	8.9	+83	+91
10	Normal	99	5.2	114	6.0	+15	+15	80	4.2	110	5.8	+30	+38
12	Normal	122	6.8	204	11.3	+82	+67	90	5.0	135	7.5	+45	+50
13	Flaccid	30	2.7	66	6.0	+36	+120	45	4.1	72	6.5	+27	+60
16	Flaccid	87	4.5	147	7.5	+60	+69	92	4.7	136	7.0	+44	+48
11	Partially flaccid	140	10.0	116	8.3	—24	—17	121	8.6	165	11.8	+44	+36
14	Partially flaccid	65	4.1	143	8.9	+78	+120	92	5.7	167	10.4	+75	+82
15	Partially flaccid	93	6.6	200	14.3	+107	+115	128	9.1	165	11.8	+37	+29
18	Atrophic	80	5.7	60	4.3	—20	—25	82	5.9	118	8.4	+36	+44
19	Atrophic	78	4.1	107	5.6	+29	+37	101	5.3	111	5.8	+10	+10
Average		102	6.1	130	7.8	+28	+27	99	6.0	134	8.1	+35	+35

In the contralateral untreated upper extremity the average blood flow increased from 113 cc. per minute (control value) to 123 cc. per minute, an average increase of 10 cc. per minute, or 9 per cent.

The control blood flow in the same 5 flaccid or partially flaccid extremities before immersion averaged 96 cc. per minute (6.4 cc. per hundred cubic centimeters of tissue per minute), with a range from 45 to 128 cc. per minute. After immersion in the bath for thirty minutes at 38.6 C. without agitation, the average blood flow was 141 cc. per minute (9.5 cc. per hundred cubic centimeters of tissue per minute), with a range from 72 to 167 cc. per minute. This represents an average increase of 45 cc. per minute, or 47 per cent (range −29 per cent to +82 per cent).

In the contralateral untreated upper extremity the average blood flow decreased from 144 cc. per minute (control value) to 135 cc. per minute, an average decrease of 9 cc. per minute, or 6 per cent.

The control blood flow in the 2 atrophic upper extremities before immersion in the whirlpool bath averaged 79 cc. per minute (4.9 cc. per hundred cubic centimeters of tissue per minute), with a range from 78 to 80 cc. per

minute. After immersion in the bath for thirty minutes at 38.6 C. with agitation, the average blood flow was 84 cc. per minute (5.0 cc. per hundred cubic centimeters of tissue per minute) with a range from 60 to 107 cc. per minute. This represents an average increase of 5 cc. per minute, or 6 per cent (range —25 to +37 per cent).

In the contralateral untreated upper extremity the average blood flow decreased from 85 cc. per minute (control value) to 59 cc. per minute, an average decrease of 26 cc. per minute or 31 per cent.

The control blood flow in 3 atrophic extremities (including the foregoing 2 extremities) averaged 90 cc. per minute (5.3 cc. per hundred cubic centimeters of tissue per minute), with a range from 82 to 101 cc. per minute. After immersion in the bath for thirty minutes at 38.6 C. without agitation, the average blood flow was 101 cc. per minute (6.1 cc. per hundred cubic centimeters of tissue per minute), with a range from 75 to 118 cc. per minute. This represents an average increase of 11 cc. per minute, or 12 per cent (range —14 to +44 per cent).

In the contralateral untreated upper extremity the average blood flow decreased from 88 cc. per minute (control value) to 87 cc. per minute, an average decrease of 1 cc. per minute, or 1 per cent.

TABLE 2. — *Blood Flow in Upper Extremities Before and After Immersion in a Whirlpool Bath for 15 to 20 Minutes at 41.0 C. to 42.5 C.*

		With Agitation						Without Agitation					
		Before Immersion		5 Min. After Immersion		Difference		Before Immersion		5 Min. After Immersion		Difference	
Subject	Condition of Extremity	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Per Cent	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Cc./100 Cc./Tissue Min.	Cc./Min.	Per Cent
1	Normal	232	13.2	232	13.2	0	0	108	6.2	247	14.1	+139	+129
2	Normal	165	7.0	294	12.5	+129	+78	173	7.4	273	11.6	+100	+58
8	Normal	126	5.9	173*	8.0*	+47	+37	131	6.1	215	10.0	+84	+64
9	Normal	255	14.2	315	17.5	+60	+24	185	10.3	317	17.6	+132	+71
17	Atrophic	174	9.7	238	13.2	+64	+37	144	8.0	204	11.3	+60	+42
Average		190	10.0	250	12.9	+60	+32	148	7.6	251	12.9	+103	+70

* Ten minutes after treatment.

The control blood flow in 4 normal upper extremities before immersion in the whirlpool bath averaged 195 cc. per minute (10.1 cc. per hundred cubic centimeters of tissue per minute), with a range from 126 to 255 cc. per minute. After immersion in the bath for periods of fifteen to thirty minutes at 41.0 to 42.5 C. with agitation, the average blood flow was 254 cc. per minute (12.8 cc. per hundred cubic centimeters of tissue per minute), with a range from 173 to 315 cc. per minute. This represents an average increase of 59 cc. per minute, or 30 per cent (range 0 to +78 per cent). The data for individual cases are shown in table 2.

In the contralateral untreated upper extremity the average blood flow decreased from 194 cc. per minute (control value) to 177 cc. per minute, an average decrease of 17 cc. per minute, or 9 per cent.

The control blood flow in the foregoing 4 normal extremities before immersion was 149 cc. per minute (7.5 cc. per hundred cubic centimeters of tissue per minute), with a range from 108 to 185 cc. per minute. After immersion in the bath for fifteen to thirty minutes at 41.0 to 42.5 C. without agitation, the average blood flow was 263 cc. per minute (13.3 cc. per hundred cubic centimeters of tissue per minute), with a range from 215 to 317 cc. per minute. This represents an average increase of 114 cc. per minute, or 77 per cent (range +58 per cent to +129 per cent).

In the contralateral untreated upper extremity the average blood flow decreased from 148 cc. per minute (control value) to 147 cc. per minute, an average decrease of 1 cc. per minute, or about 1 per cent.

A summary of all groups treated is shown in table 3. A comparison of paired determinations of the blood flow in the 7 normal and 7 diseased upper extremities before immersion and at five minutes after immersion in a whirlpool bath for thirty minutes at 38.6 C. reveals the following facts (table 1):

1. The average control blood flow before immersion into the whirlpool bath with agitation was 6.1, and without agitation was 6.0 cc. per hundred cubic centimeters of tissue per minute.

2. The average blood flows after immersion with and without agitation were 7.8 and 8.1 cc. per hundred cubic centimeters of tissue per minute, respectively.

3. The average blood flow without agitation was about 4 per cent greater than that with agitation, a difference which is not significant.

A comparison of paired determinations of the blood flow in a group of 4 normal and 1 atrophic upper extremities before immersion and at five minutes after immersion in a whirlpool bath for fifteen to thirty minutes at 41.0 to 42.5 C. reveals the following facts (table 2):

Table 3. — *Blood Flow in Upper Extremities Before and After Immersion in a Whirlpool Bath.*

Number of Subjects	Bath Temperature, °C.	Period of Immersion, Min.	Condition of Extremity	Average Total Blood Flow, Cc. Per Min. — With Agitation — Before Immersion	With Agitation — 5 Min. After Immersion	With Agitation — Difference — Cc.	With Agitation — Difference — Per Cent	Without Agitation — Before Immersion	Without Agitation — 5 Min. After Immersion	Without Agitation — Difference — Cc.	Without Agitation — Difference — Per Cent
7	38.6	30	Normal	122	139	+17	+14	104	134	+30	+29
5	38.6	30	Partial or complete flaccidity	83	134	+51	+61	96	141	+45	+47
3	38.6	30	Atrophic	79	84	+5	+6	90	101	+11	+12
4	41.0–42.5	15-30	Normal	195	254	+59	+30	149	263	+114	+77
1	42.2	30	Atrophic	174	238	+64	+37	144	204	+60	+42

2. The average blood flows after immersion with and without agitation were the same: 12.9 cc. per hundred cubic centimeters of tissue per minute.

Comment

The data presented show that agitation of the water in the whirlpool bath does not exert any effect on the total blood flow in normal, flaccid or atrophic extremities at temperatures of 38.6 and 41.0 to 42.5 C. Comparison of the average blood flow after immersion in the whirlpool bath with agitation with the average flow obtained after immersion without agitation shows essentially the same variation as the control determinations (chart 1). Furthermore, the agitation, when applied to 2 normal and to 2 flaccid extremities in a whirlpool bath at skin temperatures, did not cause erythema, thereby decreasing the probability that agitation led to reflex vasodilatation. It has been shown previously that agitation caused a decrease of bath temperature of only 0.1 degree C. This would indicate that the change of bath tempera-

ture with agitation is insignificant and does not produce a detectable effect on blood flow. Since the change of flow with agitation is very slight, the mechanical effect of agitation per se on blood flow is also insignificant.

In the normal and atrophic extremities there is only a slight increase of blood flow after immersion, despite the marked apparent redness of the skin. Within forty-five minutes the flow gradually returned to the control level

On the basis of these and other observations,[3] it appears that after immersion of an extremity in a water bath at temperatures of 38.6 to 42.5 C. there is primarily a redistribution of blood: a vasodilatation of the superficial vessels with only a slight increase of the total circulating blood volume of the limb.

Evidently there is no significant change of the blood flow of the contralateral untreated extremities.

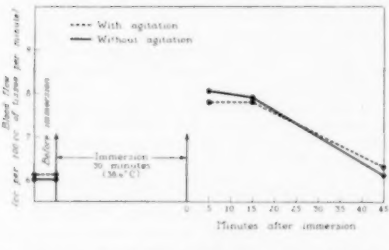
With agitation
Without agitation
Blood flow (cc. per 100 cc. of tissue per minute)
Before immersion
Immersion 30 minutes (38.6° C)
Minutes after immersion

Chart 1. — Blood flow in the upper extremities before and after immersion in a whirlpool bath at 38.6 C. for thirty minutes.

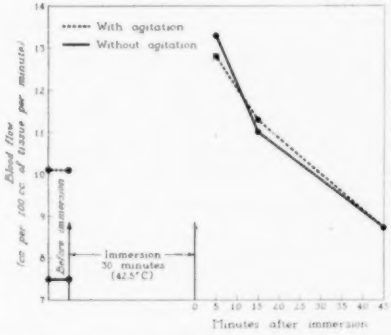
With agitation
Without agitation
Blood flow (cc. per 100 cc. of tissue per minute)
Before immersion
Immersion 30 minutes (42.5° C)
Minutes after immersion

Chart 2. — Blood flow in the upper extremities before and after immersion in a whirlpool bath at 42.5 C. for thirty minutes.

In evaluating the effect of elevated temperature on blood flow it is found that immersion of the normal limb at 38.6 C. for thirty minutes results in an average increase of flow of 21 per cent compared with an average increase of 50 per cent at 41.0 to 42.5 C. However, the greater increase of blood flow at the higher bath temperature (chart 2) was maintained for only fifteen minutes, after which the effect on the blood flow curve at 38.6 C. was similar to that at 42.5 C. This initial marked increase of flow at high temperatures may be considered a response to the greater increase of tissue metabolism. These and other observations[4] demonstrate that relatively slight elevations of temperature are adequate to cause increases of the peripheral blood flow without greatly increasing the tissue metabolism. This consideration is of particular importance in the treatment of peripheral vascular disease.

Summary and Conclusions

The effects of temperature and agitation in whirlpool bath therapy on the blood flow of normal, flaccid or atrophic upper extremities of 20 subjects were

3. Kunkel, P.; Stead, E. A., Jr., and Weiss, S.: Blood Flow and Vasomotor Reactions in the Hand, Forearm, Foot and Calf in Response to Physical and Chemical Stimuli, J. Clin. Investigation **18**:225 (Mar.) 1939. Grant, R. T., and Pearson, R. S. B.: The Blood Circulation in the Human Limb; Observations on the Differences Between the Proximal and Distal Parts and Remarks on the Regulation of Body Temperature, Clin. Sc. **3**:119 (April 28) 1938. Bancroft, H., and Edholm, O. G.: Temperature and Blood Flow in the Human Forearm, J. Physiol. **104**:366 (April) 1946.

4. Starr, Isaac, Jr.: On the Use of Heat, Desiccation and Oxygen in the Local Treatment of Advanced Peripheral Vascular Disease, Am. J. M. Sc. **187**:498 (Jan.) 1934. Benson, Simon: Volume Changes in Organs Induced by the Local Application of External Heat and Cold and by Diathermy, Arch. Phys. Therapy **15**:133 (March) 1934. Goldschmidt, Samuel, and Light, A. B.: Effect of Local Temperature Upon the Peripheral Circulation and Metabolism of Tissues as Revealed by the Gaseous Content of Venous Blood, Am. J. Physiol. **73**:146 (June) 1925. Freeman, N. E.: Influence of Temperature on the Development of Gangrene in Peripheral Vascular Disease, Arch. Surg. **40**:326 (Feb.) 1940.

studied by means of the venous occlusion plethysmograph. Paired determinations (with and without the use of agitation of the water) under identical conditions reveal the following facts:

1. The blood flow in normal and diseased extremities which were immersed in a whirlpool bath with agitation at 38.6 C. and at 41.0 to 42.5 C. did not differ significantly from that following immersion without agitation.

2. Immersion of the normal and diseased upper extremities at 38.6 C. is followed by a slight increase of blood flow, which is maintained for approximately forty-five minutes.

3. Immersion of the normal upper extremity at 41.0 to 42.5 C. is followed by a marked increase of blood flow, which is maintained for approximately fifteen minutes after treatment and a slight increase for the following thirty minutes.

Discussion

Dr. John D. Currence (New York): The observations made by Dr. Cohen and his associates are indeed commendable. Recently the medical director of a large compensation insurance company voiced the opinion to me that inefficient application of local heat is commoner than efficient application.

Ferderber and Sherman have shown that marked temperature increases in an extremity produced by short waves do not mean increased blood flow. Wilkins and associates found that increase in blood flow in fingers resulting from local heating with hot water is not so great as that produced by body warming. Bennett, Hines and Krusen advocated trunk warming by short waves in peripheral vascular disease. Freeman and Zeller determined that the volume flow of blood through the sympathectomized paws of dogs varies directly with the temperature of the bath in which the paw was immersed.

Personally, I am surprised that the agitation does not enhance the blood flow in your plethysmographic studies because I assumed that the flow would increase with the temperature. In my own experiments the axillary and oral temperatures were enhanced with agitation of water.

Using axillary and mouth temperatures as a gauge of efficiency for application of heat to an arm, our ratings are as follows: (1) whirlpool with agitator, (2) hot water, (3) infra-red radiation, (4) short waves with electrodes and (5) short waves with induction coil.

On immersing the arm about 4 inches above the elbow in water at 102 F., the axillary temperature on the treated side averaged 0.5 degree F. higher and the mouth temperature 0.2 degree F. higher with agitation than without agitation. When water at 110 F. was used with agitation, the axillary temperature rise was 1.7 degrees F.; without agitation there was only a rise of 0.8 degree F.; thus it was 0.9 degree F. higher with agitation. Oral temperatures rose 0.77 degree F. with agitation, as compared with 0.3 degree F. without agitation, which is a 0.47 degree F. greater rise when there is agitation of the water. Clinically, the redness and sensation of warmth is much greater with the agitator and the redness also persists for a much longer period of time. Relaxation of muscle spasm is markedly enhanced by the gentle vibratory massage of the agitated water.

In the final analysis, I feel that our evaluation of the use of agitation in the water surely needs more study relative to its utility as does also the evaluation of choice of the various modalities used to produce local heat.

Dr. Ferdinand F. Schwartz (Birmingham, Ala.): Certain clinical results have been noticed in the experiment. I wonder whether Dr. Cohen, perhaps, might have any idea as to what might account for those results, which do not seem to be supported by these findings in his paper — that is, whether he might have some other line of attack upon which one could work in order to explain the results, perhaps whether he would have the arms with gravity or against gravity in the whirlpool bath.

Certain clinical results have been noticed in the use of agitated water, and the temperature effects and blood flow effects by volume flow do not show any good reason for them. Might there be some other effect which is obtained that could explain them?

Dr. Ernst Fischer (Richmond, Va.): Everybody who knows how difficult the technic of these experiments is can only congratulate the authors. There seems to be one difficulty that they could not master completely. Their figures for the resting blood flow show a very large variation, even for healthy persons. Have you any idea why these differences existed? I had the impression when looking quickly over your figures that the level of resting blood flow has a certain influence upon the percentage increase observed at the end of the experimental periods. Starting with a low level of blood flow, you got a higher increase than you did when starting with an already high level of resting blood flow.

Dr. Cohen (closing): I should like to thank Dr. Currence for his discussion. It

was interesting to learn of his objective observations relative to the use of the whirlpool bath.

Concerning the other questions, it was brought out in the paper that there are always these variables — whether the arm should be supported, dependent, active or passive. In order to limit the investigation, all variables were controlled except the one we wished to study. To learn anything about the other factors, a similar extensive study would have to be repeated with the other factors in mind.

About the variation in control values, we did repeat the entire procedure with 3 of these subjects. The general results in each case were the same, although the figures were somewhat different. If there was an increase in blood flow with and without the agitation in the first procedure, when someone else repeated the procedure the same general increase in flow was found. There are enough variants in circulation, especially during sitting, as with these patients, to account for that much variation in the control values.

The vasospasm might be a factor, of course, but by using the same subjects in paired determinations and doing the procedures under the same conditions, we could assume that the 20 subjects would have approximately the same amount of spasm on different occasions and the importance of this factor would be negligible.

As far as explaining the effects of whirlpool bath therapy on other bases, there are several reasons why whirlpool is used, as mentioned in the text. This is just one piece of evidence to show that the agitation does not seem to have as much effect on blood flow as we had previously thought. Other mechanisms, such as pain threshold and nervous reflex processes, may have to be investigated further.

Dr. Wakim (closing): I should like to make one statement so that none of the clinicians will be misled by these findings. The fact that no difference in circulatory effects was observed by the presence or absence of agitation in the whirlpool baths should not be considered indicative of the uselessness of the agitator. The agitator is not used for the purpose of increasing the circulation; its cleansing and massaging effects make it very valuable in this therapeutic procedure.

In regard to Dr. Fischer's question concerning these differences, we also are surprised and are looking into the matter very carefully. We hope to find a satisfactory answer which we will share with the group next year.

THE RESPONSE OF PSYCHONEUROTIC PATIENTS AND NORMAL MEN AND WOMEN TO BRISK SUBMAXIMAL EXERCISE *

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Since exercise demands a coordinated response of many organs of the body, it is not surprising that the physiologic processes involved have been studied in a variety of disease states. Simonson and Enzer[1] in 1942 reviewed the vast amount of work which compares the response to exercise in health and in pathologic conditions and emphasized that the difference is quantitative rather than qualitative. By far the greater part of such studies have dealt with clearcut somatic disorders. In the psychiatric field, most attention has been directed towards the "effort syndrome," or neurocirculatory as-

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* Read at the Twenty-Sixth Annual Session of the American Congress of Physical Medicine, Washington, D. C., Sept. 10, 1948.

1. Simonson, E., and Enzer, N.: Physiology of Muscular Exercise and Fatigue in Disease, Medicine 21:345 (Dec.) 1942.

thenia, in which fatigue, tachycardia and breathlessness, normally associated with exercise, are present upon slight or no activity.

It has been demonstrated[2] that, when asked to work to the point of exhaustion, certain male patients free from structural disease but with complaints characteristic of neurocirculatory asthenia come to a halt earlier and present lower postexercise values for blood lactate than do normal men. Ruesch[3] reported that in an arm exercise his patients with psychoneuroses produced very little lactic acid before being exhausted. When the choice of work is moderate and such that both patients and control subjects perform a standard amount, a higher lactate rise is reported for the patients.[4] The standard deviations given indicate a considerable amount of overlapping values for the patients and the control groups, but the critical ratios are statistically significant.

Cohen and associates[1b] pointed out that the high lactate values in the patients may merely reflect a poor state of training, but, taken with evidence of low oxygen consumption obtained in other studies,[5] they suggest deficient aerobic metabolism and excessive oxygen debt. The values given for oxygen use which may be compared with those of healthy subjects are based on determinations during the first three minutes of a run on a motor-driven treadmill. Information on the postexercise oxygen debt has been furnished by Jones and Mellersh.[6] They reported an oxygen consumption during the first five minutes following a standard piece of work significantly higher on the part of their patients than of the control subjects. This was true for the group classified under "Effort Syndrome," for a group of patients in anxiety states but with no complaint of exercise intolerance and even for patients with conversion hysteria but no clinical evidence of anxiety.

If aerobic metabolism is deficient in patients with psychiatric difficulties, it is a fundamental point which should be clearly demonstrated. Observations on oxygen consumption should be made both during and after a standard piece of work and should be extended to include women. The studies here reported were designed to investigate further the physiologic response to exercise of both men and women with psychoneuroses as compared with a group of healthy normal subjects who might be considered in a similar state of general physical fitness.

Material and Procedures

Before, during, and after a standard three-minute bout of moderately hard exercise, respiratory, circulatory and metabolic observations were made. Lactate values were obtained from blood drawn from the antecubital vein before exercise, three minutes after its cessation and at the thirtieth minute of the recovery period. The colorimetric determination of lactic acid in biologic material as described by Barker and Summerson[7] was used.

The exercise consisted of a modification of the Harvard Step Test, chosen because

2. Jones, M. S., and Scarisbrick, R.: Effect of Exercise on Soldiers with Effort Intolerance, Lancet 2:331 (Sept.) 1943; (*b*) Effect of Exercise on Soldiers with Neurocirculatory Asthenia, Psychosomat. Med. 8:188 (May-June) 1946. (*c*) Cohen, M. E.; Johnson, R. E.; Cobb, S.; Chapman, W. P., and White, P. D.: Studies of Work and Discomfort in Patients with Neurocirculatory Asthenia, J. Clin. Investigation **23**: 934 (Nov.) 1944.

3. Ruesch, J.: Personality Structure, Lactic Acid Production and Work Performance in Psychiatric Patients, J. Psychol. **20**:381 (Oct.) 1945.

4. Jones, M. S., and Mellersh, V.: A Comparison of the Exercise Response in Anxiety States and Normal Controls, Psychosomat. Med. **8**:180 (May-June) 1946. Cohen, M. E., Consolazio, F., and Johnson, R. E.: Blood Lactate Response During Moderate Exercise in Neurocirculatory Asthenia, Anxiety Neurosis or Effort Syndrome, J. Clin. Investigation **26**:339 (March) 1947. Footnote 2b, c.

5. Cohen, M. E.; Johnson, R. E.; Consolazio, F., and White, P. D.: Low Oxygen Consumption and Low Ventilatory Efficiency During Exhausting Work in Patients with Neurocirculatory Asthenia, Effort Syndrome, Anxiety Neurosis, J. Clin. Investigation **25**:920 (Nov.) 1946.

6. Jones, M. S., and Mellersh, V.: A Comparison of the Exercise Response in Various Groups of Neurotic Patients, and a Method of Rapid Determination of Oxygen in Expired Air, Using a Catharometer, Psychosomat. Med. **8**:152 (May-June) 1946.

7. Barker, S. B., and Summerson, W. H.: The Colorimetric Determination of Lactic Acid in Biological Material, J. Biol. Chem. **138**:535 (April) 1941.

it was an activity with which all the subjects would be familiar. The height of the platform was 18 inches. The rate of stepping was determined by the weight of the subject so that the amount of work set for the three minute period amounted to 2,072 Kg.-M. (15,000 foot-pounds) for the men and 1,271 Kg.-M. (9,200 foot-pounds), for the women. The usual number of steps required was 63 and 47, respectively. In actual practice, owing to failures in keeping time with the metronome, the amount of work varied somewhat from that planned. The means for the different groups are given in table 1. The difference between the means for the patients and the control subjects is not significant statistically, according to the Fisher "t" values. However, since the individual variations in work done can be expected to affect the physiologic "cost" of the exercise, most of the results are reported in terms of values per 1,000 Kg.-M. of work accomplished after correction for surface area of each subject.

Anthropometric data given in table 1 show the patient and control groups to be similar in age and build except for the inclusion of 2 younger women in the group of female patients. The control subjects, 10 men and 12 women, formed a currently sedentary group, all in good health and free from any frank signs of neurosis. The women, ranging in age from 21 to 39 years, were laboratory workers, students and housewives. Three had majored in physical education in college, but only 2 of them had been actively engaged in sports within the past three years with any amount of regularity. Two subjects had no interest at all in sport; the majority enjoyed occasional swimming, bowling or tennis. The men ranged in age from 18 to 34. They were laboratory personnel,

TABLE 1.—*General Similarity in Age, Build and Work Done for Patients and Control Groups**

	Number			Work Done in Kg.-M.		
				Mean	Sigma	Fisher "t"
Female controls	12			1287	66	
Female patients	9			1269	77	0 59
Male controls	10			2079	36	
Male patients	11			2059	77	0 77
	Height in Inches			Weight in Pounds		
	Mean	Sigma	Fisher "t"	Mean	Sigma	Fisher "t"
Female controls	64 3	1 88		132 8	24 4	
Female patients	63 6	4 42	0 63	130 6	15 5	0 25
Male controls	69 4	2 80		158 3	15 2	
Male patients	69 0	3 44	0 35	160 2	23 9	0 22
	Surface Area in Sq. M.			Age in Years		
	Mean	Sigma	Fisher "t"	Mean	Sigma	Fisher "t"
Female controls	28	7		1 61	0 13	
Female patients	27	8	0 32	1 60	0 10	0 02
Male controls	24	6		1 85	0 12	
Male patients	25	5	0 42	1 84	0 16	

*N—1 is used in the computations for sigma.

†The Fisher "t" gives the ratio of difference to standard deviation with corrections made for small sample.

doctors or enlisted Navy men recently out of basic training and awaiting orders to move on. None of these subjects was particularly athletic, the majority having elected the general intramural program in school rather than being in first team competition. The 4 Navy men had had daily calesthenics in camp. Most of the men reported occasional participation in recreational swimming, squash or volley ball.

The patients studied were 11 men and 9 women drawn from the psychiatric service at the Massachusetts General Hospital, including the ward and outpatient departments, from private practice and from the Chelsea Naval Hospital. Those in the hospital were given the test within the first few days after admission in most cases. All were ambulatory, and most of them daily had some mild activity, such as volley ball, table tennis or catch. The men (18 to 35 years) gave an exercise history comparable to that of the normal subjects. The women patients, ranging in age from 16 to 34, as a group had been somewhat less active than the female control subjects. Three of them complained that they were always "too tired" even for housework. Five women reported a fair amount of exercise in the past, including roller skating, swimming, tennis and even mountain climbing. The diagnoses for the patients are given in table 2.

Examination of the data for the patients revealed no trends which could be linked with the specific diagnoses; so the male and female groups are not subdivided in the final analysis.

The experiment was performed once upon each subject except one of the female controls. Her first results are included with those of the group. Four subsequent tests at intervals within a period of six weeks showed the response in all functions except heart rate to be remarkably constant. The experiments were conducted in the morning, approximately two and one-half hours after the subjects had had breakfast. They were preceded by a thirty minute rest period with the subject in the recumbent position. During the last six minutes of this rest period, a spirogram was obtained, with use of the Benedict-Roth metabolism apparatus, which allowed analysis of the respiratory pattern as well as affording an introduction to breathing through a mouthpiece. If the heart rate were then at a steady level, the subject moved to a sitting position. The test proceeded when the heart rate reached its sitting level, usually within ten minutes.

Expired air was then collected in a Tissot spirometer over a five minute period for determination of oxygen and carbon dioxide content by the method of Haldane. By means of pens activated through an electromagnetic circuit, a kymographic record of the filling of the spirometer was obtained. With corrections for temperature and barometric pressure, this record gives minute to minute values for pulmonary ventilation. A nose clip was used, and the subject breathed through a rubber mouthpiece, inhaling

TABLE 2.—*Diagnoses at Time of Discharge for Patients Studied*

Male Patients		Female Patients	
Diagnosis	Number	Diagnosis	Number
Anxiety with fatigue	7	Hysteria	6
Reactive depression	1	Mixed psychoneurosis	3
Obsessive compulsive neurosis	1		
Mixed psychoneurosis	2		

TABLE 3.—*Comparison of Patient and Control Groups in the Pre Exercise Period**

	Blood Lactate, Mg./100 Cc.				Heart Rate			
	Mean	Sigma	Fisher "t"†	P‡	Mean	Sigma	Fisher "t"	P
Female controls	9 66	1 73			78 2	7 2		
Female patients	9 86	2 15	0 24	>0 5	86 2	12 2	1 92	>0 05
Male controls	9 03	2 55			78 5	7 8		
Male patients	8 98	2 52	0 05	>0 5	73 4	4 0	1 92	>0 05
	Oxygen per Minute, Cc.				Pulmonary Ventilation, Liters			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	238	44 1			5 06	0 75		
Female patients	238	17 8	0 00		5 74	0 96	1 87	0 05
Male controls	279	26 2			5 75	0 71		
Male patients	292	49 0	0 65	>0 5	7 30	1 11	3 78	<0 01
	Cc. O_2 per Min./P.V. in Liters				P.V./Sq.M. of Surface Area			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	47 21	4 98			3 21	0 47		
Female patients	42 67	6 44	1 82	>0 05	3 58	0 68	1 48	>0 1
Male controls	48 74	4 38			3 13	0 49		
Male patients	41 14	5 73	3 28	<0 01	3 98	0 59	3 54	<0 01

*N—1 is used in the computations for sigma.

†The Fisher "t" value is the ratio of the Diff./SD with corrections made for the small sample.

‡The P value gives the probability implication utilizing small sample theory.

room air. The spirometer was emptied after an initial collection, so that expired air displaced the room air present in the tubing at the start. The system of tubing could be mechanically supported during the sitting experiments. When the subject exercised, it was necessary for him to hold the mouthpiece in place, but support was still pro-

vided for the flexible tubing leading to the spirometer. During the three minutes of exercise, the subject breathed into the spirometer. The air expired during the first minute and a half for the men and the first minute for the women was discarded, again providing a washout of the tubing. The final collection almost filled the spirometer.

At the cessation of the exercise, the subject sat in a chair and the turn of a valve connected him with another spirometer into which he breathed for the next ten minutes. This collection required a correction for the dead space. A sample of expired air was withdrawn for analysis at the end of the first five minutes of recovery and another at the end of ten minutes. A continuous kymographic record of the ventilation was made.

Heart rate was counted by palpation of the radial artery at minute intervals for the first ten minutes after exercise. The count was made for thirty seconds of each minute, starting at fifteen seconds after exercise.

For the following fifteen minutes the subject sat quietly except for answering routine questions concerning his subjective response to the bout of work and his exercise history. The mouthpiece was then replaced, and a five minute collection of expired air was made. Pulmonary ventilation and heart rate were recorded during this period.

Results

Preexercise Data. — Analysis of the data obtained in the preliminary resting period (table 3) shows the patients and normal subjects to be very similar as far as lactate and metabolic values are concerned. The means for the groups are close and are not significantly different.

Pulmonary ventilation at rest is definitely higher for the male patients than for the controls. The probability that this difference is due to chance is less than 1 in 100. The chances are less good that the difference between the two groups of women is a significant one, the significance of the obtained difference being below the 10 per cent level of confidence.

When the pulmonary ventilation is related to the oxygen consumption, using Herbst's[8] formula for utilization coefficient ($cc.0_2/P.V.$ in liters), it is evident that the male patients have a significantly less efficient ventilation than do the control males. These observations are in accord with those of Christie,[9] Finesinger,[10] Wolf and Wolf[11] and Cohen and White,[12] which have indicated that in the neuroses overbreathing occurs. In the spirogram tracings, the incidence of irregularities is high in both groups of patients, occurring in 4 out of the 9 men and in 6 out of the 9 women, as opposed to 2 out of the 10 male controls and 3 out of 12 female controls.

The resting heart rate is on the average higher for the female patients, which was to be expected since in general the patients were more apprehensive over having the tests taken than were the other subjects. It was surprising to find the mean heart rate for male controls somewhat higher than that for the patients, but wide variation in pre-exercise rate has been reported in normal healthy young men, compatible with normal physiologic reaction to hard muscular work.[13]

Exercise. — The prescribed work was sufficient to increase the resting oxygen consumption five to six times for the females and six to eight times for the males. According to Dill's classification based on metabolic increases,[14] this would be considered "hard" work. Yet none of the subjects felt he could have kept it up all day; so it rather resembles "maximal" work performed as a burst of activity and dependent upon anaerobic processes. Act-

8. Herbst, R.: Der Gasstoffwechsel als Mass der Körperlichen Leitungsfähigkeit; die Bestimmung des Sauerstoffaufnahmevermögens beim Gesunden, Deutsches Arch. f. klin. Med. **162**:33, 1928.
9. Christie, R. V.: Some Types of Respiration in Neuroses, Quart. J. Med. **28**:427 (Oct.) 1935.
10. Finesinger, J. E.: Effect of Pleasant and Unpleasant Ideas on Respiration in Psychoneurotic Patients, Arch. Neurol. & Psychiat. **42**:425 (Sept.) 1939.
11. Wolf, G. A., Jr., and Wolf, H. G.: Studies on the Nature of Certain Symptoms Associated with Cardiovascular Disorders, Psychosomat. Med. **8**:293 (Sept.-Oct.) 1946.
12. Cohen, M. E., and White, P. D.: Studies of Breathing, Pulmonary Ventilation and Subjective Awareness of Shortness of Breath (Dyspnea) in Neurocirculatory Asthenia, Effort Syndrome, Anxiety Neurosis, J. Clin. Investigation **26**:520 (May) 1947.
13. Brouha, L., and Heath, C. W.: Resting Pulse and Blood Pressure Values in Relation to Physical Exercise and Fitness, New England J. Med. **228**:473 (April) 1943.
14. Dill, D. B.: The Economy of Muscular Exercise, Physiol. Rev. **16**:263 (April) 1936.

ually the work was short of maximal, as all the patients and all the normal subjects were able to complete the full three minutes of work. In the case of the female patients, however, encouragement and pressure by the investigators were required. Seven female patients stated they could not have continued working even one minute longer, whereas only 1 of the female control subjects felt that she had quite reached the point of exhaustion. Two of the normal men and 3 of the male patients felt that they could not have continued the exercise much beyond the period required. All subjects noted that their hearts were pounding and that respiration was markedly increased, particularly in the first few minutes after exercise. Most felt localized fatigue in their legs. The female patients described other symptoms, such as choking, weakness, "creeping" of the legs, "nervousness," pain in the back and pain in the side. One patient said "the right side always bothers me"; another, "the left side has all the trouble." The difference in the subjective

TABLE 4.—*Comparison of Patient and Control Groups During Exercise**

	Oxygen per Min., Cc.				Increase in Oxygen per Min., Cc.				Excess Cc. O_2 per Min./Sq.M./1,000 Kg.-M.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	1641	204			1404	187			1325	127		
Female patients	1550	179	1.07	>0.1	1312	182	1.13	>0.1	1286	187	0.57	>0.5
Male controls	2389	202			2111	200			858	124		
Male patients	2211	297	1.59	>0.1	1919	309	1.67	>0.1	860	222	0.02	>0.5
	P.V. 2d Min. in Liters				P.V. 3d Min. in Liters				P.V./Sq.M./1,000 Kg.-M.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	25.7	6.84			31.9	7.30			14.05	3.75		
Female patients	26.3	3.36	0.26	>0.5	31.3	3.61	0.21	>0.5	14.33	2.22	0.20	>0.5
Male controls	38.4	5.83			44.3	6.70			10.88	1.87		
Male patients	38.50	6.80	0.02	>0.5	44.5	8.42	0.07	>0.5	11.25	1.65	0.48	>0.5
	% Increase in O_2/Min.				% Increase in P.V.				Ventilation Coefficient O_2/P.V.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	606	130			473	113			59.30	12.51		
Female patients	555	99	0.98	>0.5	450	114	0.46	>0.5	54.30	7.33	1.07	>0.1
Male controls	763	96			649	162			57.54	8.85		
Male patients	689	173	1.19	>0.1	497	184	2.00	0.05	53.10	5.32	1.26	>0.1

*Determinations made during the last 1.5 minutes for the men and during the last 2 minutes for women.

response of the male patients was not markedly different from that of the normal men except that 2 of them reported a headache and 1, with paranoid tendencies, said it caused him to hear his former employer's voice. One of the male patients broke into perspiration at the first intravenous puncture but recovered his composure before the test proceeded.

The data obtained during exercise and certain derived values are presented in table 4. It may be seen that though in many cases the averages are different for the patients and the normal subjects, in most the variability about the means in both groups reduces the significance of any differences. Even in such a relatively unskilled activity as a step test the interindividual differences in economy of effort are great enough to require marked divergence between groups if any difference is to be demonstrated. In addition, large intraindividual differences undoubtedly would have occurred had the test been repeated. Taylor[15] has emphasized that intraindividual variations

15. Taylor, C.: Properties of Maximal and Submaximal Exercise with Reference to Physiological Variation and Measurement of Exercise Tolerance, Am. J. Physiol. 142:200 (Sept.) 1944.

unaccompanied with any tangible change in fitness account for a high proportion of total variance in physiologic functions measured during exercise, especially in submaximal work.

Oxygen Consumption: When the individual values for oxygen per minute in excess of resting metabolism are corrected for surface area of the subject and amount of work done, the means for the male patients and for the male controls are almost identical, though the variability of the patients is much greater (860 ± 222 cc. O_2/sq.M./1,000 Kg.-M. as opposed to 858 ± 124 cc. O_2/sq.M./1,000 Kg.-M.). The same is true for the women, though the means are slightly farther apart (chart 1). It must be remembered that expired air was collected only during the last one or one-half or two minutes

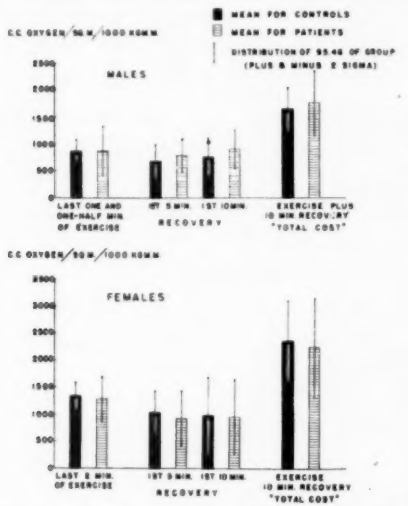

Chart 1. — Oxygen consumption in excess of resting metabolism during exercise and the first ten minutes of recovery for the control groups and psychoneurotic patients. Columns give mean values, vertical lines the distribution about the mean, N —1 being used for the calculation of sigma. The last one and one-half minutes of exercise enter into the calculation for the men, the last two minutes for the women. The exercise was a three minute step test.

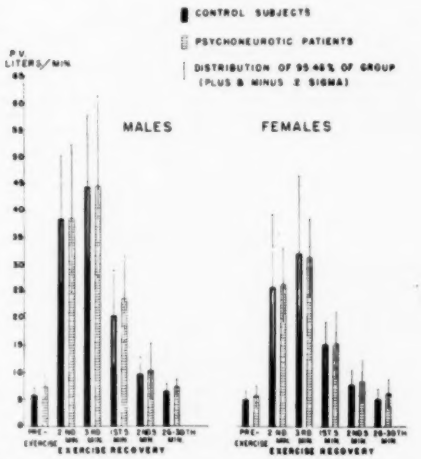

Chart 2. — Mean pulmonary ventilation before, during and after a three minute step test performed by psychoneurotic patients and control groups of normal subjects. Vertical lines indicate distribution of the individual values about the means.

of exercise; hence information is not available on the early period of the exercise.

Pulmonary Ventilation: In all subjects the maximal pulmonary ventilation was not reached until the third minute of exercise, being at that time about 4.5 times the resting value in the women of both groups, 6.5 times the resting value for the normal men and 5 times the resting value in the male patients. Although at rest the patients had given evidence of overbreathing, during the exercise the reflexes which normally regulate respiration according to need appear to have taken precedence and the figures almost duplicate the averages for the control groups (chart 2). This is true both for the absolute values and for the P.V./sq.M./1,000 Kg.-M. work (table 4).

Ventilation Coefficient: The ventilation coefficient (cc.O_2/P.V.) for both patients and controls rose during the exercise, and it became similar for all groups (chart 3). Although the means are slightly lower for both male and female patients, indicating less efficient ventilation on the average, the values

TABLE 5.—*Comparison of Patient and Control Groups During the Post Exercise Period**

	Lactic Acid 3 Min. post Exercise† Mg./100 Cc.				Lactic Acid Increase over Resting in Mg./100 Cc.†							
					3 Min. post Exercise				30 Min. post Exercise			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	35.18	10.11			25.53	9.35			7.21	3.37		
Female patients	33.24	10.42	0.43	>0.5	25.80	13.00	0.06	>0.5	8.74	6.64	0.69	>0.5
Male controls	37.95	11.85			28.90	12.40			7.60	7.83		
Male patients	44.80	12.75	1.22	>0.1	31.80	15.05	0.48	>0.5	8.70	5.01	0.39	>0.5
	Lactic Acid Increase over Resting in Mg./100 Cc./Sq.M./1,000 Kg.m. Work†								Heart Rate in 1st Min. post Exercise			
	3 Min. Post Exercise				30 Min. Post Exercise							
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	12.39	3.91			3.55	1.62			133	10		
Female patients	13.22	7.21	0.36	>0.5	4.47	2.42	1.05	>0.1	127	13	1.18	>0.1
Male controls	7.57	3.31			1.96	2.10			139	13		
Male patients	8.59	4.58	0.58	>0.5	1.98	1.32	0.03	>0.5	133	18	0.84	>0.1
	Heart Rate, 5th Min.				Heart Rate, 10th Min.				Heart Rate, 30th Min.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	96	17			94	12			87	8		
Female patients	100	12	0.61	>0.5	98	13	0.76	>0.5	94	12	1.65	>0.1
Male controls	102	12			96	11			88	8		
Male patients	94	7	1.81	>0.05	92	8	0.99	>0.1	85	6	0.93	>0.1
	Heart Rate Increase over Resting Level											
	1st Min.				5th Min.				10th Min.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	55	9.6			18	11.4			16	7.0		
Female patients	42	8.7	3.10	<0.01	15	6.0	0.85	>0.1	12	5.1	1.50	>0.1
Male controls	60	11.4			25	8.5			17	6.5		
Male patients	60	18.5	0.00		21	8.1	1.24	>0.1	18	9.3	0.28	>0.5
	Heart Rate Increase over Resting Level											
	30th Min.											
	Mean	Sigma	Fisher "t"	P								
Female controls	9	5.0										
Female patients	8	4.2	0.60	>0.5								
Male controls	9	4.5										
Male patients	13	5.5	1.56	>0.1								
	Pulmonary Ventilation in Liters per Minute											
	1st 5 Min.				2nd 5 Min.				26-30th Min.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	15.09	2.16			7.85	1.40			5.30	0.95		
Female patients	15.35	3.02	0.23	>0.5	8.55	1.87	1.03	>0.1	6.23	1.29	1.90	>0.05
Male controls	20.28	4.32			9.59	1.59			6.53	0.63		
Male patients	23.57	3.98	1.72	0.1	10.38	2.52	0.83	>0.1	7.41	0.71	3.03	<0.01
	% Increase in Pulmonary Ventilation over Pre Exercise Level											
	1st 5 Min.				2nd 5 Min.				26-30th Min.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	195	41.2			55	26.0			11	5.22		
Female patients	175	66.2	0.85	>0.1	53	38.4	0.14	>0.5	22	12.0	2.34	>0.02
Male controls	261	107.0			70	41.8			18	7.2		
Male patients	208	85.6	1.22	>0.1	97	73.3	1.01	>0.1	13	11.5	1.11	>0.1

	Pulmonary Ventilation in Liters/Sq.M./1,000 Kg.-M. Work								P.V. in Liters/Sq.M.			
	1st 5 Min.				2nd 5 Min.				26-30th Min.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	7.33	1.24	...	...	3.82	.71	...	...	3.30	0.62	...	...
Female patients	7.67	1.78	0.52	>0.5	4.29	1.13	1.88	>0.05	3.89	0.79	1.90	>0.05
Male controls	5.28	1.12	...	...	2.50	.46	...	...	3.54	0.41	...	...
Male patients	6.33	1.18	1.98	>0.05	3.10	.75	2.14	<0.05	4.00	0.41	2.42	>0.02
	% Increase in Oxygen Consumption over Pre Exercise Level											
	1st 5 Min.				1st 10 Min.				26th-30th Min.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	190	73	...	...	90	47	...	...	34.8	36.1	...	...
Female patients	153	49	1.25	>0.1	80	31	0.56	>0.5	11.0	9.3	1.57	>0.1
Male controls	190	54	...	...	116	51	...	...	11.0	6.8	...	...
Male patients	206	57	0.64	>0.5	105	33	0.57	>0.5	10.0	12.4	0.18	>0.5
	Increase over Pre Exercise Level in Cc. 0_2 Sq.M./1,000 Kg.-M. Work											
	1st 5 Min.				1st 10 Min.				1st 10 Min. plus Exercise§			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	1025.2	212	...	...	960.2	356	...	...	2368	354	...	...
Female patients	920.9	244	1.05	>0.1	943.5	350	0.11	>0.5	2230	453	0.79	>0.1
Male controls	679.0	162	...	...	755.0	176	...	...	1613	234	...	...
Male patients	774.0	147	1.38	>0.1	898.6	167	1.82	>0.1	1759	283	1.23	>0.1
	Ventilation Coefficient, Cc. 0_2 per Min./P.V. in Liters											
	1st 5 Min.				1st 10 Min.				26-30th Min.			
	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P	Mean	Sigma	Fisher "t"	P
Female controls	41.80	6.43	...	...	39.02	7.82	...	...	47.99	11.14	...	...
Female patients	39.38	6.14	0.82	>0.1	36.26	5.19	0.92	>0.1	41.60	6.60	1.53	>0.1
Male controls	40.22	5.88	...	...	38.96	5.98	...	...	45.56	5.35	...	...
Male patients	36.67	5.69	1.33	>0.1	36.61	5.32	0.90	>0.1	40.82	5.86	1.84	>0.05

*Number except where noted otherwise:
Female controls N-12
Female patients N- 9
Male controls N-10
Male patients N-11

†Female patients N-10

‡Female: controls N-5, patient N-6
Male: controls N-7, patients N-6

§1.5 min. exercise, males; 2 min., females

for the Fisher "t" are below the 10 per cent level of confidence and the differences cannot be considered significant. This change in the coefficient to a level close to that of the controls agrees with observations of Simonson and Gollwitzer-Meier,[16] who found that, while central hyperpnea was a rather regular feature in patients convalescing from infectious disease, upon exercise the ventilation coefficient approached normal figures.

Postexercise Recovery. — Blood Lactate: The average increases of blood lactate three minutes after exercise are given in table 5. They were very similar in patients and control subjects. The range of response was greater for the patients in both groups, as may be seen in chart 4 which gives the average increase in mg. per 100 cc./sq.M./1,000 Kg.-M. and the sigmas for the groups. Although the patients had some relatively high figures, there were also enough low ones to hold the average near that for the normals. At the end of the thirty minute rest period, most of the patients and controls were still above their resting level, but there was no significant difference between them.

Oxygen Consumption: Data for the recovery period are presented in table 5. No unequivocal evidence of differences in oxygen consumption was apparent between patients and control subjects in the early recovery

16. Simonson, E., and Gollwitzer-Meier, K.: Zur pathologischen Physiologie des respiratorischen Stoffwechsels; Ueber den Arbeitsumsatz in der Grippekonvaleszenz, Ztschr. f. d. ges. exper. Med. 75:330, 1931.

period. There is a slight chance that the male patients had developed a greater oxygen debt, in that for the first 10 minutes after the cessation of exercise their average increase over the resting oxygen consumption was 809 cc./sq.M./1,000 Kg.-M., compared with 755 cc. for the normal men; but the significance of the obtained difference is only between the 5 per cent and the 10 per cent level of confidence. The female patients used less oxygen on the average than did the normal women, particularly in the first five minutes of recovery, but again the variability was so great in both groups that the difference between the means is not statistically significant. A value representing "total cost" was derived by adding the excess oxygen consumption as measured during the exercise to the excess for the first ten minutes of recovery. Corrected for surface area and amount of work done, this is graphically presented in chart 1 for the four groups of subjects. The results do not differ significantly between patients and controls.

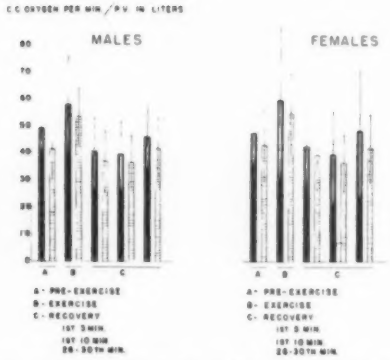

Chart 3. — Mean ventilation coefficient (cc. oxygen per minute per pulmonary ventilation in liters) before, during and after a three minute step test performed by psychoneurotic patients and control groups of normal subjects. Vertical lines indicate distribution of the individual values about the means.

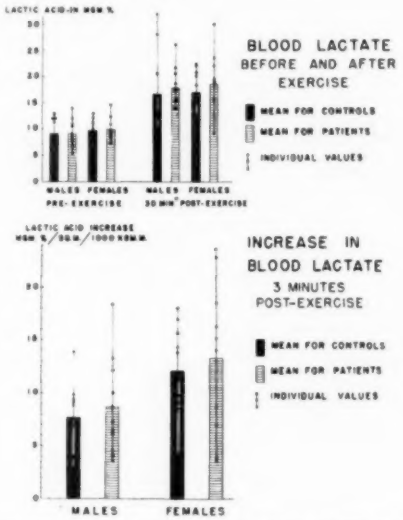

Chart 4. — Blood lactate before and thirty minutes after a three minute step test performed by psychoneurotic patients and control groups of normal subjects and the increase in lactic acid three minutes after the cessation of the activity, corrected for surface area of the subjects and amount of work done. Columns represent means for the groups; individual values are indicated on the vertical lines.

By the thirtieth postexercise minute, 58 per cent of the normal women and only 25 per cent of the female patients had resumed their preexercise metabolic rate. Margaria, Edward and Dill[17] in 1933 suggested that one third or more of the excess oxygen used in recovery may be attributed to a general metabolic stimulation rather than to a residue of oxygen debt. It is possible that such an effect might be more pronounced in the female patients. At the end of the thirty minutes of recovery, two-thirds of both groups of men had not reached their preliminary metabolic rates and had average values for oxygen per minute 10 or 11 per cent above those for resting. They had done almost twice as much work as the women and could be expected to require a longer recovery period.

17. Margaria, R.; Edwards, H. T., and Dill, D. B.: The Possible Mechanisms of Contracting and Paying the Oxygen Debt and the Role of Lactic Acid in Muscular Contraction, Am. J. Physiol. 106:689 (Dec.) 1933.

Pulmonary Ventilation: Within the first ten minutes after exercise, actual pulmonary ventilation and the ventilation corrected for surface area and work done showed very similar distributions for the female patients and their control group. In the men there appeared to be a slower return to preexercise levels on the part of the patients (chart 2), but the significance of the obtained difference at five minutes after exercise is only a possibility, being just below the 5 per cent level of confidence. At the thirtieth minute after exercise, all groups were still above their preexercise levels. At this time the averages for the male patients and controls were distinctly different, and the probability that the higher level of the patients' ventilation is due to chance is less than 1 in 100. This also holds true when the pulmonary ventilation is corrected for surface area; the probability here is closer to 3 in 100. The patients at this time had returned to their preexercise "overbreathing." The female patients presented a higher average than their controls in the late recovery period, but the probability of this being due to chance is higher, between 1 in 10 and 1 in 20.

Ventilation Coefficient: Since respiration was maintained at a high level during early recovery, the ratio of oxygen to pulmonary ventilation declined. This was true for all groups, and the values were not markedly different for patients and controls. The lowest values were obtained when the oxygen consumption and the P.V. for the first ten minutes of recovery were used in the ratio. By thirty minutes after exercise the ratio approached its pre-

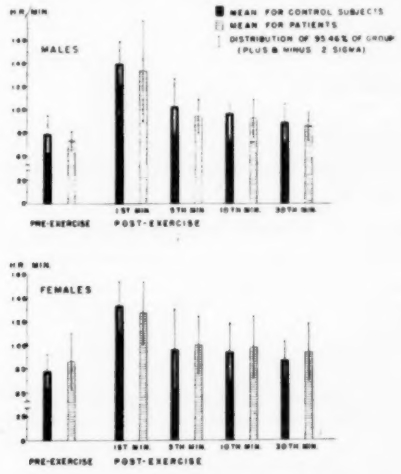

Chart 5. — Mean values of heart rate before and at intervals following a three minute step test performed by psychoneurotic patients and control groups of normal subjects. Vertical lines indicate distribution of individual values about the means.

exercise value in the patient and control groups. The higher averages for both male and female controls suggest a ventilation more efficient at this time than that of the patients. While the Fisher "t" values indicate that the probability of the means being different is below the 10 per cent level of confidence for the women and slightly above it for the men, it may be seen in chart 3 that the range of values for the control groups includes higher figures than does that for the patients. This is particularly true in the group

of normal females. At the thirtieth minute after exercise, 8 of the normal women and 5 of the female patients had an average ratio 5.3 and 5.1, respectively, lower than their preexercise values, but 4 of the normal women had averages 13.1 points higher, as opposed to 4 patients with averages 3.9 points above their preexercise levels.

In the light of the report of Barman and associates[18] that a high value for the ratio of oxygen to pulmonary ventilation is associated with a high rating for fitness for hard work, it might be considered that the differences in the coefficient here noted between patients and controls indicates a difference in general physical condition. However, postexercise lactate values, which have been shown to be influenced by the state of training of the subject[19] are not significantly different when patients and the control subjects are compared. This would suggest that the lower coefficient of the patients is a manifestation of some influence other than fitness for work.

Heart Rate: The heart rates after exercise showed a distribution no significantly different for patients and controls (table 5 and chart 5). The counts made within the first minute represented a greater average increase for the female controls than they did for the female patients, largely because the latter had in general a higher preexercise count. Again, as in the case

TABLE 6.—*Correlation Coefficients Determined by the Product-Moment Method (Pearson's "r")*

Between increase in Lactic Acid 3 minutes after exercise and excess Oxygen Consumption during and for 10 minutes following exercise.

	r
Female controls	0.58
Female patients	0.56
Female controls and patients	0.60
Male controls	0.23
Male patients	0.77
Male controls and patients	0.53

Between actual value for lactic acid 3 minutes after exercise and the ventilation coefficient O_2/P.V.

	O_2/P.V. during Exercise	O_2/P.V. during 1st 10 Min. of Recovery
	r	r
Male controls	0.61	0.49
Male patients	0.55	0.77
Male controls and patients	0.61	0.64

of the pulmonary ventilation of the male subjects, participation in the work tended to erase the differences between patients and controls, producing exercise values within the same range. The rates for both the controls and the patients dropped rapidly in the first five minutes, then more slowly for the next twenty-five. By thirty minutes after exercise, the women were, on the average, within 9 beats of their preexercise level and the men were within 12 beats, with no significant difference between patients and controls.

Relationship of Postexercise Lactate values to Metabolic Increase and the Ventilation Coefficient: The female controls and the female patients demonstrated a good correlation between their increase in blood lactate and the "total cost" (excess oxygen during the exercise plus the excess during the first ten minutes of recovery). There was little difference between pa-

18. Barman, J. M.: Consolazio, F., and Moreira, M. F.: The Relation Between Pulmonary Ventilation and Oxygen Consumption After Exercise, Am. J. Physiol. 138:16 (Dec.) 1942.
19. Robinson, S., and Harmon, P. M.: The Lactic Acid Mechanism and Certain Properties of the Blood in Relation to Training, Am. J. Physiol. 132:757 (April) 1941.

tients and controls in this respect. The values of "r" are given in table 6 and the scatter diagram appears in chart 6. In the male controls the oxygen consumption does not appear to be related quantitatively to the production of lactic acid ("r" 0.23). A high value for "r" (0.77) for the male patients indicates that in this relationship they are more like the women than like the normal men. However, it may be noted that the 1 male patient with excessively high oxygen and lactate values weights the calculation of "r" heavily.

Neither the female patients nor the female controls showed any relation between lactate production and efficiency of ventilation as measured by the oxygen to pulmonary ventilation ratio. For the men, both patients and controls, a low value for this ratio during the exercise and during the recovery period was associated with a high value for blood lactate (chart 7). The

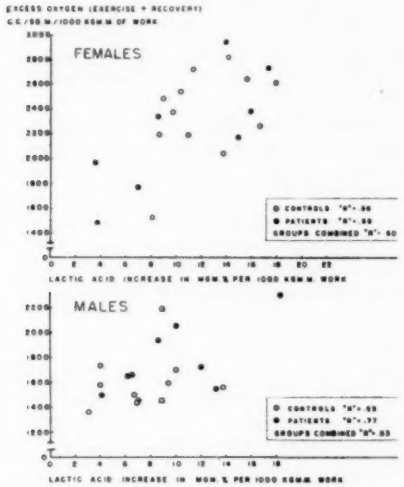

Chart 6. — Scatter diagrams showing the relationship of the increase in blood lactate corrected for work done three minutes after a step test to the excess oxygen consumption during exercise plus the excess during the first ten minutes of recovery ("total cost") for psychoneurotic patients and their control groups. The last one and one-half minutes of exercise are counted for the men; the last two minutes, for the women. Coefficient of correlation ("r") is obtained by the product moment method of Pearson.

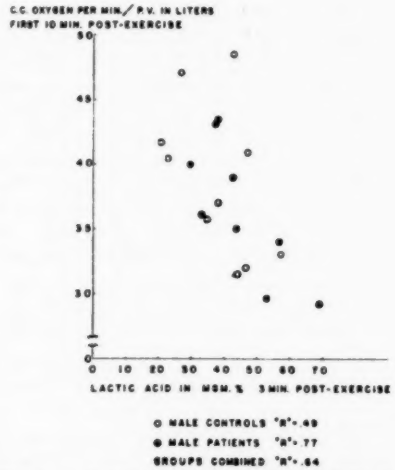
C.C. OXYGEN PER MIN./ P.V. IN LITERS
FIRST 10 MIN. POST-EXERCISE
LACTIC ACID IN MGM. % 3 MIN. POST-EXERCISE
MALE CONTROLS "R"-.69
MALE PATIENTS "R"-.77
GROUPS COMBINED "R"-.64

Chart 7. — Scatter diagram showing the correlation between the value of blood lactate three minutes after a standard step test performed by psychoneurotic patients and their control groups and the ventilation coefficient for the first ten minutes of recovery. Coefficient of correlation is obtained by the product moment method of Pearson.

close relationship demonstrated here suggests that at the intensity of work performed by the men chemical stimulation of the respiratory center is of relatively more importance than it is at the level of work performed by the females.

Comparative Responses of Men and Women Without Segregation of Data for Patients: Metheny and co-workers[20] demonstrated that in a group of normal healthy subjects the women were less fit than the men for both moderate and strenuous exertion, the differences being similar in nature to those between the trained and untrained. The results here reported are in close agreement with their observations. The maximal lactate values are similar in distribution, although the women did about 40 per cent less work

20. Metheny, E.; Brouha, L.; Johnson, R. E., and Forbes, W. H.: Some Physiologic Responses of Women and Men to Moderate and Strenuous Exercise, Am. J. Physiol. 137:318 (Sept.) 1942.

in the three minutes than did the men. The mean heart rates and their distribution immediately after exercise and during recovery are much the same for the men and women in spite of the discrepancy in work. Total cost in oxygen consumption cannot be compared, as the periods of collection of expired air differed for the two sexes. The actual value for mean pulmonary ventilation was higher in the men, but when it was related to amount of work done again the men had the advantage, with a minute volume of 11 liters/sq.M./1,000 Kg.-M. work, as opposed to 14 liters/sq.M./1,000 Kg.-M for the women.

Summary

No striking physiologic differences have been demonstrated when the response of a small group of psychoneurotic patients to a standard three minute step test is compared with that of a group of normal control subjects of similar general physical fitness. The divergence of these results from those of Jones and co-workers and Cohen and co-workers may be attributed to the choice of the control groups. In this study both men and women controls were a distinctly untrained and sedentary group and resembled the patients fairly closely in exercise history.

The patients, both male and female, produced on the average the same amount of lactic acid as their control groups did, used on the average the same amount of oxygen during exercise and early recovery, reached similar levels of ventilation during exercise and early recovery, demonstrated similar ratios for oxygen consumption during exercise in relation to pulmonary ventilation, and had similar curves for postexercise recovery of heart rate. The average values mask the greater variability exhibited by the patients in most functions, particularly in oxygen consumption during exercise and lactate values three minutes after its cessation.

A distinct difference between the patients and the control group appeared in relation to resting pulmonary ventilation. The male patients had a higher preexercise ventilation than did the controls, and, although the difference between the two groups disappeared during exercise and early recovery, the patients at thirty minutes after exercise again demonstrated a higher average.

At the thirtieth minute after exercise, more of the female patients were still above their resting metabolic level than were the female controls and fewer of their coefficients of ventilation were high, indicating a continued stimulation of the respiratory center not so closely in line with metabolic needs.

In the male patients and controls lactate values and the ratio of oxygen to pulmonary ventilation during recovery may be closely correlated. For the women, in neither patients nor controls could this relationship be demonstrated. In the women the lactate values and the excess oxygen used during exercise and recovery showed a close correlation. In this respect the male patients resembled the group of women, but the value of "r" for the normal men is very low.

It was noticeable that the patients, particularly the women, were more distressed subjectively by the exercise than were the control subjects.

Conclusions

1. Normal healthy untrained men and women show wide variations in production of lactic acid and in respiratory, circulatory and metabolic determinations during and after three minutes of work equal to 2,079 and 1,287 Kg.-M., respectively.

2. Psychoneurotic patients in age, build and exercise history similar to the normal subjects also vary widely in the physiologic response to exercise. They demonstrate in most functions studied a greater variability about their means than do the normal subjects, but the means for the groups are essentially the same as those of the controls.

3. During exercise and early recovery, the patients present average values for ventilation and heart rate closer to those for the normal groups than they did before the exercise.

4. In the men the production of lactic acid appears to be quantitatively related to the ventilation coefficient (0_2/P.V.), whereas in the women it is more directly related to the excess amount of oxygen used during exercise and recovery and is independent of the actual pulmonary ventilation.

5. The women, both controls and patients, showed themselves to be less fit for moderately hard activity than were the men, both controls and patients, even though their work load was less than that set for the men.

Discussion

Dr. Robert C. Darling (New York): I think that perhaps some of the outstanding features of this piece of work may have been missed by parts of the audience because of the somewhat undramatic results, and I should like to point out some of them. This is a fine example of several points in experimental research. First is the careful choice of control subjects which Dr. Watkins has exphasized and which I think can be properly emphasized in all studies. Second is the intelligent use of statistics to answer the questions which the average reader will wish to know. Third, there is the standardization of test procedure, which has certainly been as well done as is possible with this type of work. Actually in many cases it is next to impossible fully to standardize an exercise for a person who wishes to cheat, let us say.

There is one point in methodology which, unfortunately, Dr. Watkins could not follow. Since, as we know among individuals there is considerable variation, it is very fruitful in many instances to be able to compare the same patient with himself before and after a procedure or before and after a cure. (It is unfortunate that the psychoneuroses that he was dealing with are not readily curable.) By this means smaller differences, which could not be detected between groups of individuals, might have been detected.

As for the material reported, I think that all of us would agree that it is still axiomatic that psychologic disorders do interfere with the performance capacities of individuals. Whether that is due to purely psychologic factors concerning the "will to do" or whether there are some fundamental physiologic disturbances has not been shown by the present work. However, I hope that their negative results will not be a discouragement to further pursuit by Dr. Watkins and others of this aspect of human physiology which I think should be explored further.

Appreciation is extended to Ethel Bowie, Doris Ashton and Eleanor Cross for assistance in this subject.

A NEW DEVICE FOR MEASURING MUSCLE STRENGTH *

The Myometer

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Veterans Administration Hospital

HINES, ILL.

The importance of accurate evaluation of a disability is well recognized. Muscle strength, to a great extent, governs the amount of function of a part. The need for a small, simple, accurate device for measuring muscle strength has long existed. The myometer, which I have developed after many years of research, fills this need. It is small and compact, easily fits into the palm and weighs less than a pound. It is self contained and requires no batteries, electronic amplifiers or other electrical or mechanical connections for its operation.

The myometer is very sensitive, is extremely accurate and can be used in any position, requiring no zero, full scale or any other adjustments for operation. A maximum reading pointer on the gauge indicates the maximum force exerted at any time. This feature eliminates the necessity for the observer to watch the dial during the test, and thus to avoid distraction, which often leads to inaccuracy of testing, whenever it is necessary to observe the reading during the actual test. The physician or therapist can thereby concentrate on the action of the muscle under test. The amount of force exerted in testing is read after the individual test is completed.

Apparatus

The myometer consists of a cylindrical housing 2 inches in diameter and 3¼ inches long, which encloses the complete operating mechanism. Extending from one end of the housing is the shaft and pressure-transmitting button. Enclosed at the other end, and visible through a transparent plastic cover, is a dial gauge. This gauge has a manually operated reset maximum reading pointer that remains at the maximum reading until it is manually reset back to zero. A built-in hydraulic pressure converter transmits the linear force exerted on the button to the pressure gauge. There are no springs, cams, levers, or cables to transmit this force from the button to the gauge proper.

In order to measure accurately the strength of different muscles, the device is made in three ranges: 0 to 5 pounds, 0 to 15 pounds and 0 to 60 pounds. When there is merely minimal contraction, the 0 to 5 pounds range is used for extreme accuracy. It is felt that muscles having a strength of over 60 pounds need not be measured with a gauge. All the myometers, with three different ranges, are of identical size; however, they are finished in three different distinguishing colors.

When this device is used in testing larger muscles, a pressure equalizing disc 2¼ inches in diameter is interposed between the pressure-transmitting button and the skin, in order to distribute the force used over a larger area, making for added comfort to the patient and eliminating the possibility of any harmful pressure effects on the tissues. Only a very short movement of the button gives complete range on the gauge. A positive operating safety feature prevents overloading of the gauge.

Technic of Using the Myometer

The patient is placed in a comfortable position, in a well lighted room. The physician or therapist applies a force with the myometer sufficient to overcome the resistance (isometric contraction) offered by the patient's muscle or muscle

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groups. The myometer is held so as to apply the force at a definite point, at right angles to the part.

In the initial testing and in rechecking the muscle strength at a later date, or if the muscle is to be tested by another person, it is important that the force through the myometer be applied at the same point, in the same direction and in the identical position in relation to the pivot of the joint. The point on a part where the force is to be applied should have a definite relation to some anatomic landmark — e. g., a bony prominence, a permanent blemish, a scar on the skin, etc.

If, owing to marked muscle weakness, the patient is unable to move the part against gravity, the part can be placed so that gravity is eliminated before the test is begun. Many of the procedures used in manual muscle testing can

Fig. 1. — Method of testing the strength of the flexor digitorum profundus muscle.

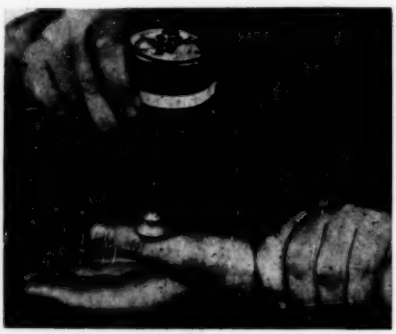

Fig. 2. — Method of testing the strength of the abductor pollicis brevis muscle.

Fig. 3. — Method of testing the strength of the abductor digiti quinti muscle.

Fig. 4. — Method of testing the strength of the extensor muscles of the wrist. The force exerted by the Myometer is transmitted through the pressure-equalizing disk.

be followed when the myometer is used; however, there is the advantage that with the myometer an accurate definite value of the force in pounds or fractions thereof can be secured, resulting in a more scientific technic.

The following technic is used for testing several typical muscles and muscle groups with the myometer. Figure 1 shows the technic of testing the strength of the flexor digitorum profundus muscle of the index finger of the left hand

The patient is resisting the force (exerted by the myometer) attempting to extend the flexed terminal phalanx of the index finger while the middle phalanx is fixed. After the resistance of the muscle has been overcome, the myometer is taken off the finger tip and the maximum reading on the gauge noted.

Figure 2 shows the technic of testing the strength of the abductor pollicis brevis muscle of the left hand. The patient is resisting the force (exerted by the myometer) attempting to overcome the strength of the abductor pollicis brevis muscle.

Figure 3 shows the technic for testing the strength of the abductor digiti quinti muscle. The patient is resisting the force (exerted by the myometer) attempting to overcome the strength of the abductor digiti quinti muscle. The pressure-transmitting button is placed on the lateral side of the finger, just proximal to the proximal interphalangeal joint.

Figure 4 shows the technic for testing the strength of the extensor muscles of the left wrist. The patient is resisting the force (exerted by the myometer) attempting to overcome the strength of the wrist extensor muscles. The exerted force is being transmitted through the pressure-equalizing disk for added comfort and lessened pressure effects.

Fig. 5. — Method of testing the strength of the flexor muscles of the elbow. The force exerted by the Myometer is transmitted through the pressure-equalizing disk.

Figure 5 shows the technic for testing the strength of the flexor muscles of the right elbow. The patient is resisting the force (exerted by the myometer) attempting to overcome the strength of the flexor muscles of the right elbow. The exerted force is being transmitted through the pressure-equalizing disk. Other muscles and groups of muscles are tested in a similar manner with the myometer.

Summary

The myometer, a new device for accurately measuring muscle strength, has been described. It measures the resistance offered by a muscle in isometric contraction, the reading on the gauge being equal to the force necessary to over-

come the isometric contraction of the muscle under test. It is extremely important when repeating muscle tests to use identical procedure and technic in order to assure identical conditions. Different physicians or therapists using the myometer on the same muscle or muscle groups with the same technic will secure practically identical results for the muscle strength readings.

This device is self contained, is light in weight and gives a direct reading. A maximum reading pointer eliminates the necessity of watching the gauge during the test, enabling the observer to concentrate on the muscle action. The three different ranges permit testing to be done up to a force of 60 pounds, which should adequately cover the ranges of muscles with subnormal strength. When desired, the myometer can be held in clamp fastened to or pivoted from a table, stand or similar support.

The myometer is a valuable adjunct, leading to a more precise and scientific evaluation of impaired neuromuscular function and a more accurate determination of the effect and value of prescribed treatment.

I am indebted to the Medical Illustration Laboratory of the Veterans Administration Hospital, Hines, Ill., for the photographs.

MEDICAL NEWS

Dr. Krusen Honored

Dr. Frank H. Krusen has recently been honored by receiving honorary membership in the Section on Physical Medicine of the Royal Society of Medicine. This recognition, according to the citation, is in appreciation of the great services rendered by Dr. Krusen in the realm of Physical Medicine and with the hope that he "will long continue in your great research work and teachings."

F. Wilson Ille, Noted Manufacturer, Dies

F. Wilson Ille, pioneer in the field of hydromassage and prominent manufacturer of underwater therapy equipment, died of a heart attack on March 22 at his home, 67 Rocky Wood Road, Manhasset, N. Y. He was born at Ilion, N. Y., 69 years ago.

Since early life he was associated with manufacturers of electromedical equipment. In 1918 he organized his own company and in 1922 incorporated the present firm, The Ille Electric Corporation. He created the modern hydromassage method of underwater treatment and developed new electromechanical equipment in this field for the after-care of polio victims, crippled children and wounded war veterans. He devoted his life's work to this cause and became an outstanding manufacturer in this line. He carried on his work along scrupulously ethical lines and made many friends among the medical profession. The ARCHIVES extends sincere sympathy to his widow, Mrs. Marie T. Ille.

Boston University Confers Honorary Degrees

In a special annual Founders' Day Convocation, held in Boston, March 14, President Edwin I. Marsh of Boston University conferred academic honors on Dr. Howard Rusk and Miss Catherine Worthingham. Dr. Marsh's citations were as follows:

Howard A. Rusk, physician extraordinary, professor and head of the Department of Rehabilitation and Physical Medicine at New York University College of Medicine, Associate Editor of the New York *Times,* editing news in fields of medicine, health and physical education, a servant of society in whose career exalted patriotism and exact science are blent like bells of sweet accord, I confer upon you Boston University's honorary degree of *Doctor of Science.*

Catherine A. Worthington, Director of Professional Education of the National Foundation for Infantile Paralysis, Incorporated; distinguished authority in fields of vocational rehabilitation, occupational therapy, physical therapy and corrective physical education: because of your consecration of expert knowledge to the service of the physically unfortunate and handicapped, full many a healed cripple may rise up to call you blessed, I confer upon you Boston University's honorary degree of *Doctor of Science.*

Dr. Dinken Promoted

Dr. Harold Dinken has recently been advanced from Associate Professor to Professor of Physical Medicine and Rehabilitation and Head of the Department of Physical Medicine and Rehabilitation at the University of Colorado Medical Center.

Dr. Jessie Wright Medical Director of New Cerebral Palsy Center

Dr. Jessie Wright, director of the D. T. Watson School of Physical Therapy, was recently named medical director of the new cerebral palsy center of the Beaver County, Pa., Society for Crippled Children. Dr. Wright in addition to being medical director of the D. T. Watson School of Physical Therapy is also on the staff of the Children's, the Psychiatric, Municipal and Montefiore Hospitals, Pittsburgh.

Special Exhibit on Physical Medicine and Rehabilitation During Annual Sessions of the American Medical Association at Atlantic City, June 6 to June 10

This exhibit includes physical therapy, occupational therapy and rehabilitation and is sponsored by the Baruch Committee on Physical Medicine. It is presented under the auspices of the following committee: Frank H. Krusen, Rochester, Minnesota, chairman; Winfred Overholser, Washington, D. C., and Howard A. Rusk, New York. The detail of this exhibit follows:

Howard A. Carter and Frederic T. Jung, Council on Physical Medicine, American Medical Association, Chicago, Illinois:

Biophysics and physical medicine: The demonstration will be divided into four parts: (1) use of an oscillator and amplifier to demonstrate on the spot the effect of changing frequency of electrical currents ranging from 100 cycles per second to 200,000 per second, (2) use of a simple volt-ohmmeter to permit an on-looker to measure his own resistance, (3) mercury drop experiment to show the effects of direct current as compared with alternating current and high frequency currents in a manner analogous to the effects on muscle and nerve under electrical stimulation, (4) demonstration of inverse square law employing radiation instruments to show reduction in intensity of radiation as the distance is made greater.

Julia F. Herrick and Joseph P. Engel (by invitation), Institute of Experimental Medicine, Mayo Foundation, and Section on Physical Medicine, Mayo Clinic, Rochester, Minnesota:

Fundamental studies on microwave diathermy and measurement of temperature: The demonstration will be divided into four parts: (1) demonstration of a new microwave transformer (matching animal tissue to free space), (2) demonstration of screening of microwave diathermy, (3) demonstration of a portable thermometer for measuring cutaneous temperatures, and (4) demonstration of the use of thermistors for measuring temperature of the body.

Gordon M. Martin, Section on Physical Medicine, Mayo Clinic, Rochester, Minnesota:

Therapeutic exercises: The exhibit will demonstrate the importance of therapeutic exercise as a clinical measure for use in many conditions seen in general practice. Actual programs of exercise as applied in several common pathologic conditions will be shown. The requirements for successful employment of therapeutic exercise will be presented.

Miland E. Knapp and Frederic J. Kottke, Division of Physical Medicine, University of Minnesota School of Medicine, Minneapolis, Minnesota:

Physical medicine and rehabilitation of fractures: The exhibit will consist of demonstrations upon actual subjects of proper methods of physical treatment and rehabilitation of certain types of fractures commonly encountered in general practice.

F. A. Hellebrandt, Baruch Center on Physical Medicine, Medical College of Virginia, Richmond, Virginia; and Walter S. McCelllan, Medical Director, Saratoga Springs Commission, Saratoga Springs, New York:

Spa theapy in the United States: The value of information concerning the facilities at various accepted health resorts in the United States will be stressed and it will be shown how health resorts serve the medical profession in the areas of general hygiene, dietary control, graduated exercise, physical therapy and diversional activities.

Winfred Overholzer, St. Elizabeth's Hospital, Washington, D. C.:

Occupational therapy in psychiatry: The importance of occupational therapy in the management of psychiatric patients will be pointed out. Suitable apparatus and therapeutic procedures will be demonstrated. The major indications for occupational therapy will be cited.

Sedgwick Mead, Washington University School of Medicine, St. Louis, Missouri:

Physical treatment of backache: A study of the factors contributing to the disability commonly referred to as "chronic low backache" will be presented. Methods of physical treatment and rehabilitation will be demonstrated. Anatomical studies, electromyographic studies and physical therapeutic procedures will be discussed.

A. B. C. Knudson, Division of Physical Medicine Rehabilitation, Veterans Administration, Washington, D. C.:

Rehabilitation of the hard of hearing: This exhibit will demonstrate the testing of hearing, fitting of hearing aids, speech reading, auditory training and a brief history of hearing aids from speaking trumpets to present devices. Samples of hearing aids now in use will be shown.

Howard A. Rusk, Department of Rehabilitation and Physical Medicine, New York University, College of Medicine, New York; Jayne Shover (by invitation), National Society for Crippled Chil-

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ARCHIVES of PHYSICAL MEDICINE

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL MEDICINE

.·. EDITORIALS .·.

AMERICAN BOARD OF PHYSICAL MEDICINE

The next examinations for the American Board of Physical Medicine will be held Saturday and Sunday, June 4 and 5, 1949 at the Jefferson Medical School, Philadelphia. The Secretary is Dr. Robert L. Bennett, Georgia Warm Springs Foundation, Warm Springs, Georgia.

EXIT EMPIRICISM

Physical Medicine has long been accused of too much empiricism in the use of various physical agents. In defending his position as a specialist in a scientific branch of medicine, the physiatrist is still too frequently embarrassed by the necessity of telling his confreres that we don't know exactly what are the effects of a variety of commonly used treatments.

Basic and clinical research should in time fill these voids in our knowledge. The reports which find their way into the literature most commonly are those relating to some new and at times dramatic physiologic effect or clinical benefit. Other studies as carefully planned and executed bring only negative or undramatic results. These experiments should not be overlooked, however, as they are equally important in giving us a rational basis for treatment and often point the way to other crucial experiments. The first three papers of this issue of the ARCHIVES are examples of research projects in Physical Medicine which aid in developing the scientific background of our specialty. They are worthy of careful study, even though their news value is limited, for they aid in destroying the bugaboo of empiricism.

In the same issue we can point to something new from one of our most energetic and ingenuous members. In our search for more accuracy in measurements, which is natural in a specialty based on physics, one of the directions has been toward dependable methods of assaying muscle strength. The myometer of Newman is most appealing as it gives us a new tool of quantitation which is small, not unnecessarily elaborate, and easy to use. The goal of finding an accurate numerical muscle strength testing system is still unattained, however, because of the complexity of the testing procedures. In the first place, the test positions used must be standardized, the placement of the force measuring instrument must be uniform, and the patient must be stabilized adequately. Interpretation of results so that a value in pounds can be related to muscle function poses another problem which extends into the fields of mechanics and anthropology. All this should serve as a challenge to us to increase our investigative efforts and come up with the answers. Newman has aided us by developing an instrument which should eliminate the factor of judging strength by our subjective kinesthetic sensations. The remainder of the solution will require a systematic attack and a large number of observations including controls subjected to statistical analysis. The results, even should they be negative, will be of value and may move us a step further in dispelling empiricism.

THE FOURTH POSTGRADUATE COURSE IN PHYSICAL MEDICINE AND REHABILITATION AT GALVESTON, TEXAS

Following the welcome call from the Medical Branch of the University of Texas, physicians and physical and occupational therapists from 28 States and Canada again assembled at Galveston, Texas, from February 28th to March 4th, 1949, to participate in the fourth consecutive postgraduate course in Physical Medicine and Rehabilitation. Some 27 guest speakers from all parts of the United States and 14 members of the faculty of the Medical Branch of the University of Texas acted as instructors, among them: Robert L. Bennett of Warm Springs, Georgia; O. Leonard Huddleston, Los Angeles, Calif.; Frederic T. Jung, Chicago, Ill.; Henry H. Kessler, Newark, N. J.; Miland E. Knapp, Minneapolis, Minn.; A. B. C. Knudson, Washington, D. C.; Richard Kovács, New York City, N. Y., and James B. Mennell of Los Angeles, Calif., now on his return trip to London. The program was again extremely instructive and varied. It included fundamentals as well as advanced topics, with special emphasis on the newer aspects of rehabilitation and with symposia on Poliomyelitis and Cerebral Palsy and on Physical Medicine in Neuropsychiatry. At the end of the session, a morning was given over to discussion by the speakers of questions submitted in writing regarding the topics presented. A number of the early morning lectures were attended in a body by the freshman class of over 100, a laudable effort for their early indoctrination about the possibilities of modern physical medicine. Chief credit for this well planned and exceedingly well executed program again is due to Dr. W. S. Selle, Director of Medical Physics and of the Postgraduate Course in Physical Medicine, and to the unstinted support of the leaders of the Medical School, among them the genial C. D. Leake, Vice-President and Dean; D. Bailey Calvin, Dean of Students and Curricular Affairs; Truman G. Blocker, Director of Postgraduate Studies and others. Miss Ruth Decker, Technical Director of Physical Therapy assisted at all demonstrations and was host at the inspection of the spacious and well equipped new department of physical medicine and rehabilitation of the medical school.

The evenings during the course were devoted to the showing of educational movies and social programs. One evening, the inimitable Capt. R. J. Murphy of Washington, D. C., arranged a hilarious comedy sketch and an enjoyable musical program with the aid of Dr. F. T. Jung and an able cast of amateur whistlers; another evening the guest speakers were entertained on the famous Balinese pier. At the customary Annual Dinner the program was all Texan, including some remarkable showing of tissue cultures by Dr. Pomerantz, biologist. The weather during the week was generally quite favorable and there was much promenading in the bright sun along the famous Sea Wall. Although the number of participants this year was a little less than last year's record attendance, the unquestionable success of the fourth Postgraduate Course again demonstrated the possibilities of just such a course for refresher study for the older workers and for the acquisition of authoritative information for the beginner and as a desirable opportunity for relaxation and social contact for all participants. It is to be hoped that this course will continue to be held for many successive years. Physicians and technicians in all parts of the country will do well to plan in advance to devote the first week of March for a combination of postgraduate study and a stimulating social time on the Treasure Island of Texas. R. K.

Medical News
(Continued from page 238)

invitation), National Society for Crippled Children and Adults, Chicago, Illinois, in collaboration with the American Speech and Hearing Association:

Speech rehabilitation: This exhibit will consist of six booths, each dealing with one phase of speech therapy, i. e. (1)) stuttering, (2) articulation, (3) cleft palate, (4) cerebral palsy, (5) post-laryngectomy and (6) aphasia. In each booth a physician who specializes in the management of the particular speech defect, a speech correctionist and a speech therapist will demonstrate the appropriate methods of speech therapy on a patient suffering from the condition under consideration.

Henry H. Kessler, Hasbrouck Heights Amputee Clinic, Hasbrouck Heights, New Jersey:

Physical rehabilitation of amputees: Modern methods of rehabilitating persons having major amputations of the upper and lower extremities will be demonstrated. Proper use of the prosthesis will be shown.

Arthritis and Rheumatism

An intensive study of arthritis and rheumatism will be initiated at the University of Wisconsin as the result of a gift of $10,300 from the Thomas E. Brittingham trust fund. Dr. D. M. Angevine and Dr. C. H. Altshuler of the department of pathology, who have been conducting histochemical studies of rheumatic disease for the past two years, will receive $5,300 to finance their work. Four thousand dollars will be used for electromyographic apparatus for the study of muscular changes in arthritic conditions. Dr. Harry Bouman of the department of physical medicine, an authority on muscle physiology, will be in charge of the study.

Dr. C. V. Seastone of the department of microbiology, who has worked on streptococci infections for many years, will use $1,000 of the gift to investigate sensitization reactions to streptococci in rheumatic and arthritic states.

VA Eliminates Branch Offices

The Veterans Administration announces the selection of five key points from which medical supervision of hospitals and other VA medical matters will be carried on. They are Atlanta, Boston, Fort Snelling, Minn., San Francisco and St. Louis.

The plan for medical supervision from these points resulted from the elimination of the 13 Branch Offices of VA where medical activities have previously been under the direction of Branch Medical Directors. All functions of former branch office medical staffs are now centered in the office of the Chief Medical Director in Washington.

In connection with medical matters handled in Washington, it is necessary to have representatives traveling throughout the country. For the sake of reduced traveling expense and other economies, certain Central Office representatives will be stationed at strategic points, to serve as the eyes and ears of the Chief Medical Director.

It was emphasized that in no sense will these official stations become operating offices. They will simply be points from which Central Office personnel will travel.

This change in supervisory activities will bring supervision of the Chief Medical Director closer to hospital and other medical activities in the field, thereby assuring maintenance of the finest medical service to veterans.

Educational Therapy Conference

Under direction of Veterans Administration Physical Medicine Rehabilitation Division, Central Office, Washington, D. C., an *"Educational Therapy Conference"* for the Tuberculous patient was held March 21 to 25, 1949, at Swannanoa Division VA Hospital, Oteen, North Carolina.

The following physicians participated: Drs. A. B. C. Knudson, Chief, Physical Medicine Rehabilitation Division, Central Office, Washington, D. C., Donald C. Covalt, Director of the Institute of Physical Medicine, Rehabilitation, New York University, N. Y.; George D. Wilson, Consultant, Physical Medicine, Branch No. 4, Asheville, N. C.; B. B. Bagby, Jr., Chief, Physical Medicine Rehabilitation Service, Oteen, N. C.; Frank P. Ilasi, Assistant Chief, Physical Medicine Rehabilitation Service, Oteen, N. C.; David Roberts, Assistant Physical Medicine Rehabilitation Service, Swannanoa, N. C.; A. Ray Dawson, Chief, Physical Medicine Rehabilitation Service, McGuire VA Hospital, Richmond, Virginia, and James M. Dunn, Central Office, Washington, D. C., presiding.

All phases of the rehabilitation of the tuberculous were discussed followed by inspection tour of the complete rehabilitation program at both Oteen and Swannanoa VA Hospitals as set up in the recently published Swannanoa Plan.

Physical Medicine and Rehabilitation

Excellent round table discussions on physical medicine and rehabilitation were a part of the Massachusetts Health Conference, held recently in Boston. At the first session the following were considered: General Statement of the Problem of Rehabilitation, by Nathaniel W. Faxon, M.D., Director, Massachusetts General Hospital; Vocational Rehabilitation in Massachusetts, Mr. Edward D. Callahan, Milton, Director, Division of Vocational Rehabilitation, Massachusetts Department of Education; Rehabilitation Within the Veterans Administration, Jacob L. Rudd, M.D., Chief of Physical Medicine and Rehabilitation, Veterans Administration Facility, West Roxbury; Rehabilitation in Relation to workmen's compen-

sation, Mrs. Emma S. Tousant, Commissioner, Massachusetts Industrial Accident Board.

At the second session the topics presented were: Physical Medicine, Arthur L. Watkins, Chief of Physical Medicine, Massachusetts General Hospital; Rehabilitation of the Athritic Patient, Walter Bauer, M.D., Associate Professor of Medicine, Harvard Medical School; Rehabilitation in Industry, Mr. Stanwood L. Hanson, Assistant Vice-President, Liberty Mutual Insurance Company; Rehabilitation of the Patient with Heart Disease, Lewis C. Robbins, M.D., Chief, Heart Demonstration Unit, Newton Health Department; Rehabilitation and Readjustment of the Blind, The Rev. Thomas J. Carroll, Director, Catholic Guild for the Blind; The Problems Confronting the Amputee, George W. Van Gorder, M.D., Visiting Orthopedic Surgeon, Massachusetts General Hospital.

On the second day of the conference, the program was as follows: Rehabilitation of the Epileptic, Miss Esther C. Walther, Past Executive Secretary, American Epilepsy League; Rehabilitation of the Paraplegic Patient, Donald Munro, M.D., Chief, Department of Neurosurgery, Boston City Hospital; Rehabilitation of the Crippled Child and the Poliomyelitis Patient, William T. Green, M.D., Clinical Professor of Orthopedic Surgery at Harvard Medical School and Head of the Department, Children's Medical Center; Speech Rehabilitation, Wilbert L. Pronovost, Ph.D., Director of Speech Clinic, Boston University; Rehabilitation of the Emotionally Disturbed Individual, Henry H. Brewster, M.D. Assistant, Psychiatrist, Massachusetts General Hospital; The Role of the Medical Social Worker in Rehabilitation, Mrs. Dorothy Oates, Supervisor of Physical Restoration, Division of Vocational Rehabilitation, Massachusetts Department of Education and The Future of Rehabilitation, Sidney Licht, M.D., Chief of Physical Medicine and Rehabilitation, Veterans Administration Branch Office No. 1.

Those responsible for this fine program were: Chairman of the Panel, Arthur L. Watkins, M.D.; Co-Chairman, Mr. A. Dudley Britton, with a committee composed of Joseph S. Barr, M.D., Mr. Harold Russell, Nathaniel W. Faxon, M.D., Augustus Thorndike, M.D. and Mr. Parker Trowbridge.

Temporary Physical Therapists for Poliomyelitis

Upon request from the National Foundation for Infantile Paralysis the Amerisan Physical Therapy Association will assume the responsibility of recruiting and assigning physical therapists for emergency work with infantile paralysis patients beginning May 1, 1949. Physical therapists who have one or more of the following qualifications will be referred to temporary emergency positions:

1. Graduates of physical therapy schools approved by the Council on Medical Education and Hospitals of the American Medical Association.
2. Members of the American Physical Therapy Association.
3. Senior registrants of the American Registry of Physical Therapy Technicians.

If you will be available for temporary emergency work in poliomyelitis epidemics during 1949 please notify:

Polio Recruitment Service,
American Physical Therapy Association,
1790 Broadway,
New York 19, New York.
Telephone, JUdson 6-2932.

Salaries are $260 monthly for staff physical therapists and $285 for supervisory and administrative positions. Travel expenses are paid and $75 per month for maintenance where it is not furnished by the institution and the physical therapist is working away from home.

The American Physical Therapy Association would like to receive suggestions as to how they may assist in coordinating the work of emergency physical therapists to provide better patient care and to be of greater service to physical therapists.

International Congress on Rheumatic Diseases

Much interest is centered in the forthcoming nternatiional Congress on Rheumatic Diseases which will be held at the Waldorf Astoria in New York City, May 30 to June 3, 1949.

Some of the interesting aspects of the tentative program are: "Muscle physiology in relation to arthritis," a formal paper to be presented by Dr. Donald Solandt, of Toronto, Wednesday morning, June 1; a clinic session at the New York Hospital, Wednesday afternoon, June 1, on "Fibrositis and disorders of soft tissues"; a clinic session at the Rehabilitation Center of New York University on the afternoon of Wednesday, June 1, on "Rehabilitation of arthritis"; a clinic session at Bellevue Hospital, Friday afternoon, June 3, on "The painful shoulder" and another clinic session on Friday afternoon, June 3 at the Polyclinic Hospital on "Physical medicine in arthritis and related disorders." Dr. Richard Kovács will preside. The program is as follows:

"Spa therapy for patients with rheumatic disease," Walter S. McClellan, M.D.
"The effect of some common drugs on the temperature of joints and related structures," by Drs. Joseph L. Hollander, and Steven M. Horvath.
"Experimental studies on blood flow in deep tissues," by Drs. Harry M. Hines; Alfred W. Richardson, and Miss Barbara L. Feucht.
"Physical measures in the management of low back pain," by Dr. Hans Kraus.
"Treatment of symptoms arising from the cervical spine," Dr. John McM. Mennell.

Among the many foreign guests who will contribute to the program there are:

Lord Horder, London, "Rheumatism, a National problem."
Jacques Forestier, Aix-les-Bains, France, "The treatment of progressive rheumatism with copper salts."
Imre Barsi-Basch, of Budapest, "Transfusions of blood from pregnant women in patients with rheumatoid arthritis."

Eric Jonsson of Stockholm, "Relations between rheumatic fever and rheumatoid arthritis."
Professor S. de Seze of Paris, "Procaine infiltration in painful musculoskeletal disorders."
Svend Clemmesen, Copenhagen, "Statistical analysis of 1000 cases of rheumatoid arthritis in relation to insidious and acute onset, menopause, pregnancy, psoriasis, ankylosing spondylitis and Still's disease."
Dr. William Tegner of London, "Some aspects of psychogenic rheumatism."
Henrik Seyfarth of Oslo, "Muscle soreness and myosis as a symptom of chronic overstraining, especially in neurotics."
P. Barcelo of Barcelona, Spain, "Chronic polyarthritis and psoriasis."
Veikko Laine of Heinolan, Finland, "Involvement of the nervous system in rheumatoid arthritis."
Fernando H. Ramos of Montevideo, "Periarthritis of the shoulder."

The official languages of the Congress will be English, French and Spanish but instantaneous translations of the scientific papers given at the plenary sessions will be made by means of the I. B. M. wireless system. The meeting is open and the registration fee is $10.00. The meeting is sponsored by The International League Against Rheumatism, the host is The American Rheumatism Association of which Dr. Robert M. Stecher, City Hospital, Cleveland, Ohio, is President.

April Meeting New York Society of Physical Medicine

Wednesday, April 6, the New York Society of Physical Medicine will present an evening's program devoted to the subject of braces. Dr. S. Epstein (by invitation) will discuss "Meaningful occurrences in the history of bracemaking and braces"; Dr. H. H. Jordan, "The science and art of braces"; Dr. M. Shimberg (by invitation), "The significance of braces in rehabilitation," and Dr. A. S. Abramson, "Principles of bracing in paraplegia."

Dr. Karsner Retires at Western Reserve

Dr. Howard T. Karsner, professor of pathology at Western Reserve University School of Medicine since 1914 and director of the Institute of Pathology, will retire from the medical faculty at the close of the present academic year. He will then become medical research advisor to the Surgeon General of the Navy. Dr. Karsner is the author of the well known book "Human Pathology," published in six editions.

Report from Uruguay

Physical medicine has taken the place it deserves in medical teaching in Uruguay. In the new plan, the school of medicine organized a professorship in physical medicine, under Dr. Mario Cassinoni, who last year visited several specialized institutes abroad. Physical medicine is taught by the professor and his assistants to medical students in their last years. At the same time, organized postgraduate courses of physical medicine are also given. The professorship is a branch of the "Instituto de Radiología y Ciencias Fisicas." Due to the influence of European medicine in the medical schools of all South America, physical medicine and radiology are closely related.

During this year the "Consejo Directivo de la Facultad de Medicina" approved the project of creating a school for physical therapy technicians; this will be the first one in South America filling a real need and will mark a milestone in the development of physical medicine. In addition, a high class service in physical medicine is being organized in a model hospital, the "Hospital de Clínicas," and this will be the place for practical teaching of physical medicine.

Among other activities in the field of physical medicine in Uruguay, the work of the "School F. D. Roosevelt for Crippled Children" must especially be mentioned. This school was organized by Mrs. Marisa Lusiardo de De León, and is doing a remarkable work as the first school for crippled children in South America. It is hoped that physical medicine will soon be one of the most important and interesting subjects for medical students and teachers in Uruguay. (Report received from Dr. Mario Cassinoni, Fellow of the American Congress of Physical Medicine.)

Seminar on Physical Medicine

This seminar, designed for general practitioners and specialists interested in the more effective use of physical medicine was held at the March meeting of the Pennsylvania Academy of Physical Medicine, Medicine, in Reading Pa. The chairman was Dr. G. M. Piersol and those who participated were: Charles A. Furey, M.D., "Rehabilitation of a Stroke"; "Backache," Harold Lefkoe, M.D.; Albert A. Martucci, M.D., "Treatment of Peripheral Vascular Disease"; William H. Schmidt, M.D., "Shoulder Lesions"; "Internal Dearrangements of the Knee. Their Diagnosis and Treatment," by Herman J. Bearzy; "Facial Paralysis, Etiology and Treatment," by Frank L. Follweiler. The evening session consisted on a panel discussion on "Arthritis" from the viewpoints of the internist, presented by Irvin Herman, M.D., the rheumatologist, as given by Richard T. Smith, M.D.; the orthopedist, as presented by Anthony DePalma, M.D.; the psychiatrist, as given by Paul Ponisard, M.D., and the physiatrist, as discussed by Carl Levenson, M. D.

BOOK REVIEWS

MEDICINE. Volume I: THE PATIENT AND HIS DISEASE. By *A. E. Clark-Kennedy*, M.D., F.R.C.P., Physician to the London Hospital and Dean of the Medical School. Cloth. Price, $6.00. Pp. 383. Williams & Wilkins Co., Mount Royal and Guilford Aves., Baltimore 2, Md., 1947.

This is the first volume of a series which approaches the practice of medicine with the hope of developing an ideal physician who would be capable of knowing completely about every specialty and able to integrate and interpret perfectly the physiologic with the pathologic processes. In addition to all this he is to be able to understand how the mind affects all these reactions. This is a big order. Not all will agree that the author accomplishes this, but he does have a viewpoint which is worthy of respect.

The chapter on symptoms is subdivided into various groups such as pain, flatulance, shortness of breath, etc. These symptoms are considered in a rambling, disconnected manner, intentionally so. This same plan is continued in the next chapter where the signs are considered regionally; for example in discussing joints, a paragraph tells about why a joint stands out with atrophy of muscles, why an acute knee is held flexed and why a chronic knee is held in a contracted position — no mention is made of the diseases or disorders that may cause these objective signs. This is the pattern throughout the book.

Chapter IV on heredity and environment is a combination of fact and philosophy which is interesting and makes for good reading. However, many will disagree with his thoughts and explanations; for example in a sub-title "Consciousness" his reference to the part various religions play in controlling the human mind and human acts. The following remarks on degeneration are evidence of his style "what is going on in that mind which for so long has seemed to be slowly wearing itself away from human life? He may die, like Lear, suddenly. If not, the majesty of age declines. The man who has survived all the risks in the environment sinks into a state of childishness and dementia, and ultimately becomes unconscious on account of thrombosis or hemorrhage in the brain. The body may linger on for a while after the mind is dead. Then, at some point in the progressive process of disintegration of structure and functions, the circulation fails. Nutrition can no longer be maintained. Coordination fails suddenly, precipitating death."

This book will probably not be a "best seller" or a book purchased by a busy practitioner or medical student who are looking for a book which in outline forms covers the causes, signs, symptoms and treatment of heart diseases in three pages or the functions of the liver in one-half a page but on the other hand it will not be a book that will be outdated in one year or several years.

The hopeful trend of medicine today is to think of the entire patient and not of an organism made up of individual organs and systems. The author has secured a certain measure of success to further the cause in trying to "present the whole of medicine . . . and intentionally avoided classifying subject matter in a way in which it would be easily remembered." The following quotation probably best summarizes his manner of thinking and writing "life of a man depends on the three comparable facts: his genetic plan, the environment in which he lives, and the way in which he lives the life. The last depends on the use which he makes of his mind and the exercise of his own free will."

OSTEO-ARTHRITIS OF THE HIP-JOINT. By *H. Warren Crowe*, D.M., B. Ch. (Oxon.), M. HS, L. B. C. P. (Lond.), Senior Physician, Charterhouse Rheumatism Clinic. Fabrikoid. Price, $7.00. Pp. 70, with illustrations, The Rolls House Publishing Company, Ltd., 2, Breams Buildings, London, E. C. 4, England, 1948.

As stated in the author's preface this monograph reports only ". . . the results of (his) personal experience . . ." including not only osteo-arthritis of the hip joint, but "all forms of rheumatic arthritis of that joint, at whatever age it occurs." The report covers a series of 500 patients treated since 1927 (though only 263 form the basis for statistical analysis of results). It is proposed that ". . . once the methods here advocated become generally used, the Surgeon will no longer have to advocate fixation of the joint as the only remedy for intolerable pain."

After an introductory survey of the literature, the normal and pathologic anatomy of the hip joint and etiology of osteo-arthritis are discussed. A brief section on the diagnosis and examination of the patient would have been improved by illustrations and photographs in at least an amount proportionate to the many (116 roentgenograms on twenty-four plates, fifteen photographs and diagrams, two photomicrographs) and sometimes helpful plates in other sections of the book. Treatment, including the use of vaccines, intra-articular injections, physical therapy, ancillary measures and surgery is sketchily covered in only sixteen pages. The author states, "I still rely on vaccines to arrest the progress of the disease." His proponents will uncritically nod their assent; his critics will find the evidence for such reliance still unconvincing.

In the abstract of case 2 (a man 41 years old) (appendix I, p. 55), it is implied that the use of vaccines, intra-articular injections and removal of

focal infection not only relieved the patient's symptoms of osteo-arthritis (present five years) but also freed the urine of sugar (previously found to be present in "considerable amounts with some acetone"). Whether a determination of blood sugar was made is not stated, but "no special diet was ordered during this period."

This book incompletely fulfills the requirements for the critical type of presentation so necessary at this time in the field of the therapy of chronic articular diseases. It undoubtedly will find its widest acceptance among the followers of the author's theories and concepts of treatment previously published.

CONCISE CHEMICAL AND TECHNICAL DICTIONARY. Edited by *H. Bennett*, Technical Director, Glyco Products Co., Inc. Cloth. Pp. 1120. Price, $10.00. Chemical Publishing Co., Inc., 26 Court Street, Dept. FM, Brooklyn 2, 1947.

This is an extremely useful compilation of accurate and up-to-date information regarding chemical, bacteriologic, pharmaceutical, physical, biologic, mechanical, medical and electrical terms. Of particular interest to physicians are the many chemical formulas; statements of the chemical and physical properties of natural and synthetic drugs; definitions of biologic terms; descriptions of the compositions, properties and uses of many proprietary products, and many conversion tables for weights, measures, temperatures, specific gravities, and so forth. This dictionary can be unhesitatingly recommended to supplement the purely medical dictionaries in a physician's library.

DEEP MASSAGE AND MANIPULATION ILLUSTRATED. By *James Cyriax*, M.D., B.Ch. (Cantab.),; Physician to the Department of Physical Medicine, St. Thomas' Hospital, London. Third edition. Fabrikoid. Pp. 278, illustrated. Price, $5.00. Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 49 East 33rd Street, New York 16, 1948.

There is little available in the technical literature of physical medicine describing in adequate detail specific types of massage and manipulation to be applied to the various parts of the body. This book is written to supply this lack and thus to serve as an aid in the training of physical therapists. Photographs are used to show the position of the patient and the therapist's hands. The description accompanying each photograph serves as an adequate prescription or order for the doctor to give to the technician. Most physiatrists in this country would doubtless emphasize the combined use of other agents in their prescriptions such as heat in various forms and active exercise. The amount of pressure, the range of movement, the duration of the treatment, of course, are still only approximately indicated and are part of the art of physical therapy. The book, then, only partially fills its objective, the rest must come by experience. As is appropriate in a book primarily for the use of technicians, differential diagnosis is omitted. Physicians should be interested in these methods of treatment and will be intrigued by the good results almost uniformly reported. Acceptance of the diagnosis of "fibromyositis" is essential for utilization of these procedures.

Those familiar with the previous edition will find little change other than a few more photographs which uniformly are of good quality as is the type and paper.

MATHEMATICAL BIOPHYSICS. A Revised Edition Including Recent Developments in the Field and Most of the Text of Advances and Applications of Mathematical Biology. By *N. Rashevsky*. Cloth. Price, 7.50. Pp. 669, with illustrations. The University of Chicago Press, 5750 Ellis Avenue, Chicago 37, 1948.

This book will not interest the average physician, unfortunately, unless he is particularly interested in biology. It is an excellent book and the subject matter is well presented. For the physician who has a good background of mathematics the subject matter will be intriguing. The book represents the result of eleven years of research by the author and his assistants. A large part of the work has never before been published. It is as the author states an attempt at presenting the first results in a very young and new field. The final goal of such studies should be the building up of a mathematical biology standing in the same relationship to experimental biology as mathematical physics stands to experimental physics. The volume is divided into four main parts: 1, mathematical biophysics of vegetative cells; 2, mathematical biophysics of excitation and conduction of peripheral nerves; 3, mathematical biophysics of the central nervous system; 4, the organism as a whole and the organic world as a whole.

THE COMMON SENSE PSYCHIATRY OF DR. ADOLF MEYER. Fifty-Two Selected Papers Edited, with Biographical Narrative by *Alfred Lief*. Cloth. Price, $6.50. Pp. 677. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y., 1948.

Dr. Adolf Meyer, whose contributions to American psychiatry have placed him as the outstanding nature of the psychobiological school, which insists on unity of mind and body in the human person and believes in treating the "whole" patient, has followed those principles since his student days in Europe. He was born on September 13, 1866, in the Swiss parish of Niederweningen, near Zurich, the son of a Zwinglian minister. Young Adolf decided early to study medicine and pursued his aim vigorously through studies at the European centers of education under the outstanding medical men of the day. After receiving his medical degree in 1892, he declined to take up psychiatry in Switzerland. He came to America where an honorary fellowship at the University of Chicago and a meager private practice con-

stituted his entrance into professional life here. This source book, which points out the evolution of Meyer's thought, traces the development of his common sense approach to the problems of psychiatry from the time of his earliest work in Kankakee, Illinois, in 1893, through the years in Worcester, Massachusetts, New York City and Baltimore, where he was chief psychiatrist at the Johns Hopkins Medical School for almost thirty years. It presents Doctor Meyer's teaching in his own words of his principle of treating the whole patient, mind and body and provides as well a fascinating story of his life and work.

HEALTH AND PHYSICAL EDUCATION FOR JUNIOR AND SENIOR HIGH SCHOOLS. By *David K. Brace,* Chairman, Department of Physical and Health Education, University of Texas. Fabrikoid. Pp. 392. Price, $4.00. A. S. Barnes & Company, 67 W. 44th St., New York 18, 1948.

This is a book presenting a curriculum in health education and physical education consisting of carefully designed units of instruction. Part one is devoted to organization and administration for the purpose of giving teachers and school administrators a common understanding of the basic policies. Part two discusses health education under twenty units. Part three gives a thorough discussion of physical education outlining thirty-five units and includes the dance, team sports, recreational sports and combatives. An appendix gives an excellent bibliography for health education, a directory of producers and distributors of films, films for physical education and a bibliography of physical education. For those interested in the organization of a program of physical education in the junior and senior high school this volume is recommended.

INTRODUCTION TO ORGANIC AND BIOLOGICAL CHEMISTRY. By *L. Earle Arnow,* Ph.D M.D., Director of Research, Medical Research Division, Sharp & Dohme, Inc., Glenolden, Pa.; Formerly Assistant Professor of Physiological Chemistry, University of Minnesota Medical School, Minneapolis, and *Henry C. Reitz,* Ph.D., Assistant Professor of Biochemistry, Purdue University, Lafayette, Indiana; Formerly Assistant Professor of Agricultural Chemistry, University of Florida, Gainesville, and Assistant Professor of Agricultural Biochemistry, University of Minnesota, St. Paul. Second Edition. Cloth. Pp. 795, illustrated. Price, $5.75. C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo., 1949.

This is a textbook written for college students preparing for medical or dental schools. The book is divided into three parts. Part I is a cursory review of chemical and physical phenomena. Part II covers organic chemistry including all of the more important subjects in a manner that should stimulate interest and make the acquisition of the knowledge of these fundamentals more than a problem of memory. Part III considers biochemistry and includes chapters on carbohydrate, protein and fat metabolism, enzymes, respiration, hormones and vitamins. A vast amount of information is covered in a few pages which unless a student has had preliminary studies might tend to confuse him with so many facts.

This is the second edition. This reviewer is not acquainted with the first edition but according to the publisher this edition has had new sections added on "antimalarials, fluorine compounds, silicons, mercaptans, penicillin and the microbiological assays of amino acids." The other chapters show evidence of revision to bring the book up to date.

The authors have presented the subject clearly and interestingly, particularly Part II, so that it would help the student master this relatively difficult material. Following each chapter are numerous questions which should aid the instructor. Sufficient modern references are included to make it possible to follow any subject more fully.

The overabundance of formulas might frighten the student and although the author remarks that the "actual writing of the formulas and equations cannot be emphasized too strongly" it is questionable whether students at that stage of their education should make the attempt to commit to memory anywhere near the number that are shown. This effort to force complicated and numerous formulas should discourage rather than benefit the student. A minor fault could be found in the photographs and illustrations which might be improved by better selection and clearer reproduction.

HUTCHISON'S FOOD AND THE PRINCIPLES OF DIETETICS. Revised by *V. H. Mottram,* M.A. (Cant.). Sometime Fellow of Trinity College, Cambridge, and Late Professor of Physiology at King's College of Household and Social Science, University of London, and *George Graham,* M.D. (Cant.), F.R.C.P. (Lond.), Consulting Physician to St. Bartholomew's Hospital. Tenth edition. Cloth. Pp. 727. Price, $6.75. The Williams & Wilkins Company, Mount Royal and Guilford, Baltimore, 1948.

Almost the whole of Part I, diet in normal life, is new, for the energy problem had to be restated in view of the extreme variability of the individual; the minimal protein intake to be reviewed in the light of evidence from the experimental use of isotopes; work upon the factors influencing calcium uptake and the effect of trace elements included and the section on vitamins thoroughly reviewed and especial reference made to "reflection" of the B group and the practical applications of that knowledge. Two new brief chapters on the processing and hygiene of food have been incorporated into this part. Part II, the nature of foods, has been further compressed and rearranged to give a somewhat more logical order of treatment. Part IV, diet in treatment of disease, has been much modified and expanded. For example, the sections on obesity, diseases of the liver, rickets and scurvy have been revised and

largely rewritten. The book retains it right to be considered a classic in this field.

NURSING OF CHILDREN. By *Gladys Sellew*, B. S., R. N., Ph.D., Associate Professor of Sociology, Rosary College, River Forest, Ill. In Collaboration with Sister *Annette Walters*, M.A., Ph. D., Chairman, Psychology Department, College of St. Catherine, and Sister *Ann Harvey*, B.S., M.D., Directory, Nursery School, College of St. Catherine. Sixth edition. Cloth. Pp. 486 with 84 illustrations. Price, $3.75. W. B. Saunders Company, West Washington Square, Philadelphia 5, 1948.

The continued popularity of this textbook on nursing created the necessity for a sixth edition. Certain additional sections have been added such as a new chapter on the adolescent, with emphasis placed on the implications for preventive medicine, and the peculiarly disrupting influence of physical handicaps occurring during adolescence.

PHYSIOTHERAPY (FIZYKOTERAPIA). A HANKBOOK FOR PHYSICIANS AND MEDICAL STUDENTS (in Polish). By Dr. *Jozef Jankowiak*, Former Chief of Naturotherapy, Workmen's Compensation, Poznan and Warsaw, Poland. Pp. 447, with 104 illustrations. Second Edition. Panstwoma Skladnica Ksiegarska, Warsaw, Poland, 1948.

The author of this volume has been active in physical therapy for a great many years, and in accordance with the limited possibilities of equipment, his main field of activity appears to have been in hydrotherapy. The first 212 pages are devoted to this division; there are 82 pages on heliotherapy, 100 pages on electrotherapy; 23 pages on massage and exercise and 11 pages on institutional work. A better paper for printing appears to be the chief difference from the first edition which appeared two years ago. It is quite evident that the author worked under the handicap of having had no access to the newer English and American literature, although some of the earlier works are cited in a few places. Most of the methods enumerated and illustrated are from the German literature, many of them obsolete. Such recent developments in the field of the physical medicine, as rehabilitation or occupational therapy are not even mentioned. The therapeutic possibilities of many of the enumerated procedures are overrated.

A TEXTBOOK OF GENERAL PHYSIOLOGY. By *Philip H. Mitchell*, Ph.D.; *Robert P. Brown*, Professor of Physiology, Brown University. Ed. 4. Cloth. Pp. 927, illustrated. Price, $7.50. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y., 1948.

It is ten years since the last edition of this popular book appeared. It has been much revised in keeping with the newer knowledge in this important field. A new chapter entitled "Intermediary Metabolism" has been added which considers the metabolism of the three basic foodstuffs individually and how they are interrelated. Other chapters which have been changed include those on excitation and contraction, the structure of living matter, permeability of cells and nutritive requirements.

This book is intended for the college student who had sufficient work in the fundamental biological subjects and chemistry and who wishes to study the more fundamental aspects of physiology particularly as it applies to the human organism. It is neither too difficult nor too simplified, and, as in the past, should serve as an excellent text book.

WRITE AND SPEAK BETTER. By *William G. Hoffman*, Professor of English and Public Speaking, College of Business Administration, Boston University, and *Roy Davis*, Head of the Department of English, College of Business Administration, Boston University. Cloth. Pp. 437. Price, $3.50. Whittlesey House, A Division of the McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y., 1948.

On occasion, requests are received from physicians and others who are preparing articles for publication regarding reference books in English grammar and composition which will aid them in writing the article. One of the best of these is this book by Hoffman and Davis. Although it is a textbook, it is intended for the writer and speaker who intends to convey information by way of the English language rather than for the would-be novelist, dramatist or poet; the end sought is clarity rather than beauty. The directions regarding grammar and punctuation are concise and good; the materials dealing with organization of the article are extremely valuable. The chapters on oral delivery could be profitably studied by every author who intends to read a paper before an audience.

INTRODUCTION TO PHYSIOLOGICAL CHEMISTRY. With Laboratory Experiments. By *L. Earle Arnow*, Ph.G., B.S., Ph.D., M.B., M.D. Director of Research Medical, Research Division, Sharp & Dohme, Inc., Glenolden, Pennsylvania; Professor of Chemistry, Bryn Mawr College Summer School of Nursing, Bryn Mawr, Pennsylvania, 1941-1943, 1945; Formerly Assistant Professor of Physiological Chemistry, University of Minnesota Medical School, and Lecturer in Physiological Chemistry to Students Enrolled in the University of Minnesota School of Nursing, Minneapolis. With an Introduction by *Katharine J. Densford*, R.N., B.A., M.A., D.Sc., Professor of Nursing and Director of the School of Nursing, University of Minnesota, Minneapolis. Third edition. Fabrikoid. Pp. 595, illustrated. Price, $4.00. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, 1949.

A textbook for a school of nursing revised since the last edition printed in 1943.

PHYSICAL MEDICINE ABSTRACTS

The Care of Injuries to the Semi-lunar Cartilages of the Knee. Thomas P. Butcher.

J. Kansas M. Soc. **49**:511 (Dec.) 1948.

The diagnosis of injury (usually tear and dislocation) of the semi-lunar cartilages of the knee and also the reason for operation upon these cartilages depend essentially on one observation, and that is locking of the knee so that it cannot be fully extended. Preparation for surgery may well include preoperative quadriceps exercises so as to expedite these after operation. A twenty-four hour sterile preparation is recommended. Postoperative pain often is severe, but early quadriceps exercise is commenced the day after operation and weight bearing permitted in four to eight days. A splint or cast is not recommended. Simple foot weight-lifting with the patient seated on a desk or table is started within a week and increased as rapidly as tolerated until 40 to 60 pounds are being successfully lifted. The patient should, in four to six weeks, be able to lift several more pounds with the operated leg than with the good one.

Indications for Joint Manipulation. John Bastow.

Proc. Roy. Soc. Med. **41**:615 (Sept.) -1948.

Once the diagnosis has been established, what type of case does respond well to manipulation? The most successful cases are those following "minor trauma."

Here persistent pain, typically on movements in one or two specific directions and often accompanied by local tenderness and some swelling, which persists for weeks after a sprain or twist, and where a bony lesion has been excluded by roentgenogram and an inflammatory or neoplastic lesion by careful study of the case, is usually due to an adhesion which responds readily to manipulation under anesthesia. Joints chiefly affected are the midtarsal and metatarsal joints of the foot; the ankle; the knee; the lumbar region of the spine; the cervical spine; the shoulder and the wrist.

Where the adhesion does not lie in the synovial membrane or capsular ligaments of a joint but in the attachment of a tendon or muscle, or between a tendon and its synovial sheath, manipulation without anesthesia is more effective, as the patient's involuntary resistance to the movement is essential to the success of the operation.

Examples are "tennis elbow" affecting origin of extensor tendons of forearm, tendon adhesions in the long head of the biceps or in the extensor tendons of the wrist and adhesions between the small muscles of the back. In such cases, the tissues are otherwise normal and a normal range of movement may be expected to be obtained.

Another example is postfibrositic stiffness, either following an acute attack of fibrositis, which has subsided leaving some loss of function or persistent pain, or else as the sequel of long-continued chronic fibrositis.

In a similar category are the stiff neck following brachial neuritis and the stiff shoulder following adhesive pericapsulitis, but only when the acute stage has subsided. Here it usually is wise to warn the patient that two or three serial manipulations may be required and some temporary exacerbation of symptoms may follow each operation.

In osteoarthritis manipulation is of definite value, but great care must be taken to study the radiographs and attempt to regain only such a range of movement as the alteration in the contour of the articular surfaces and the contractures in the surrounding muscles and ligaments will allow. Each manipulation must be followed by conscientious active exercises on the part of the patient, if any improvement gained by the movement is to be retained. The deep hot pool bath with an attendant in the water to assist in the patient's movements is especially valuable in this condition.

Hips, shoulders, knees and spinal joints respond well on the whole.

In rheumatoid arthritis, manipulation should never be employed in the acute stage with the idea of increasing movement or a joint. It may be used to correct flexion contracture if the joint is immediately immobilized by splintage in the corrected position, with the proviso that after twenty-four hours the splint is removed for a period daily to allow active movement and so prevent the development of ankylosis.

In the chronic stage, manipulation often is of value in increasing the range of movement of a stiff joint, but the radiograph must first be carefully studied to determine the amount of articular erosion that has taken place.

A full, normal range of movement can hardly ever be expected, and so manipulation must be guarded and no more force employed than the decalcified bones and fibrotic extra-articular tissues will stand.

Dangers of Local External Heat and Trauma to Ischemic Tissues in Peripheral Vascular Diseases. Roy J. Popkin.

California Med. **69**:374 (Nov.) 1948.

Every textbook discussing peripheral vascular diseases mentions the possibility of gangrene, burns or ulcer formation following the application of what normally would be considered safe and therapeutic amounts of heat.

Ischemic tissues tolerate the local application of heat poorly. The basic principles are physiologic and mechanical. These principles are enumerated. Heat accumulates more quickly in ischemic tissues. The local heat regulatory mechanism cannot function properly. The normal physiologic response to a rise in the environmental temperature of an extremity is an increased blood flow. On the application of external heat the vessels dilate, resulting in an increased flow of fresh blood which carries the heat away. Ordinarily this increased flow carries the locally heated blood to other parts of the body, chiefly to the surface, where the mechanism of radiation and increased perspiration cool it to normal. In the patient with arterial occlusion the increased blood flow is restricted. As a result the heat quickly accumulates in the tissues to dangerous levels.

External heat increases the metabolic activity of the cells. More oxygen is required and more waste products are formed. As a result, an increased blood flow is required. This increased demand cannot be met. The cells suffer acutely from the inability of the stenosed or occluded vessels to permit an increased blood flow required by a rise in local environmental temperature. Cangrene frequently supervenes.

Ischemic tissues lose their ability to discriminate between dangerous and safe degrees of heat. Nerve structures are very sensitive to a reduction in blood flow. Degenerative changes occur early. The receptor organs for warmth lose their efficiency. A much greater degree of heat is required to stimulate these end organs than would normally be necessary. It is possible for the person to apply burning degrees of heat to an ischemic extremity without being aware of it.

Physical Medicine and Psychiatry. Some Interrelationships. Winfred Overholser.

J. A. M. A. **136**:1221 (Dec. 25) 1948.

The more recent work in the field of what has come to be rather cumbersomely termed "psychosomatic medicine" has done much to bring together the thinking of the psychiatrist and the physiatrist. Psychosomatic medicine is, strangely enough, not a new term. It was used in psychiatric literature in Germany over one hundred years ago.

More recently another type of treatment long used in psychiatry has been officially taken under the aegis of physical medicine, namely, occupational therapy. Occupational therapy, that is, the application of various types of occupation to the treatment of neurologic and psychiatric disorder, is a valuable adjunct to the application of physical means, such as heat, electricity and massage. Occupational therapy gives vent to the patient for his aggressions; it redirects his interest in topics outside himself and can be useful in developing skills and talents and in determining emotional and physical limitations and handicap levels.

Reassurance and encouragement may, of course, be overdone, but when they are properly administered they can be extremely useful for the patient's peace of mind and happiness. The confidence of the operator, his readiness to deal with situations as they come up and his general behavior are more important than words in giving a feeling of assurance and confidence to the patient.

In certain types of cases it is obvious that massage and other physical manipulations should be avoided on account of their erotic effect. This is especially true in patients with a pronounced homosexual component, for example. The possibility that the symptoms complained of may be essentially psychogenic should never be overlooked. In an interesting study published recently by Watkins, Cobb, and others, it was found in a series of 45 patients who complained of fatigue that about 80 per cent of them were suffering from anxiety neurosis. There is a danger in such cases that overattention to the physical complaint may serve, so to speak, to fix it by directing attention to it and make it more difficult to deal with by psychotherapy. The author states that he does not mean by this that the physiatrist should try to make a psychiatrist of himself any more than the reverse should be the case.

Psychosomatic Medicine: Problems in the General Hospital. John F. Williams.

South. Med. & Surg. **110**:302 (Oct.) 1948.

The traditional training given in most medical schools and hospitals has omitted considering the treatment and nursing care of the patient with psychosomatic illness. Because of this it is difficult and often impossible to obtain in the general hospital the minimal care needed for these patients. Early ambulation helps greatly to cut short the postoperative period and the hospital stay. In addition to its known physiologic benefits it is of obvious psychologic value. Any reasonable means of eliminating the need for the time-honored soap-suds enema and the perils of the bedpan and urinal will do much for the morale of any patient. Apprehension is the product of our times and it is a responsibility to prevent additional psychologic illness by our cooperative efforts.

Causalgia. A General Discussion. Harris B. Shumacker.

Surg. **24**:485 (Sept.) 1948.

Though every effort was made to segregate such cases in special centers where the best opportunity existed for their careful evaluation and treatment the enormous volume of work, the limited personnel and the lack of availability of certain apparatus precluded particular studies which in retrospect would have been informative.

It would seem important to study the vasomotor responses in each patient by every available method, including digital plethysography and venous occlusion plethysmographic blood flow methods whenever possible. It will be profitable to pursue further the reaction of patients to alterations in the state of vascular tonus induced

by various methods and to study the effect of a variety of drugs affecting autonomic function, including such agents as tetraethylammonium chloride. It will be important to correlate better the time of onset of vasodilatation and of pain relief following sympathetic block and to evaluate carefully any persistence of pain during spinal anesthesia. Particular study must be made of cases of incomplete relief of pain after sympathectomy. The so-called atypical causalgias require further clarification. It is hoped that more animal experimentation may throw new light on the problem of the nerve pathways and the mechanism of pain. Better understanding of the fundamental problems connected with major causalgia may be of aid in understanding more clearly the other allied painful states.

The Physiologic Effects of Physical Therapy. George Morris Piersol.

Ann. Int. Med. 30:69 (Jan.) 1949.

Physicians continue to show considerable skepticism as to the advantages of physical medicine. This attitude is due in no small measure to the belief that physical medicine does not rest on a sound physiologic basis. The purpose of the paper is to point out that the most useful and commonly employed procedures in physical medicine, i. e., the use of various forms of heat and cold, massage and therapeutic exercise, depend for their effectiveness on well established physiologic reactions.

Heat, in some form, applied generally or locally, represents the therapeutic measure most frequently used in any department of physical medicine. A summary of one year's experience in a general hospital showed that of 23,345 treatments given in the department of physical medicine heat was a feature in 44.3 per cent of cases. Next to heat came massage, 34 per cent, and then therapeutic exercise, 15.4 per cent.

Horvath states that two factors must always be considered in heat therapy, the amount of heat successfully applied into the tissues and the extra amount of heat produced in the tissue as a consequence of the oxidation processes that have been accelerated by the heat applied. These factors deserve careful consideration when heat therapy is contemplated.

Collections of inflammatory exudate in skin and muscles may be dissipated by massage. As pointed out by Scull, massage involves the application of the stimulus of pressure to tissues. It has been shown that in normal subjects massage has no significant effect on pulse rate, blood pressure or oxygen consumption.

The interest of the physiatrist centers chiefly about corrective exercise, which has been defined as the scientific application of bodily movements in the treatment of disease or malfunction. The subject has attained increasing importance of late because of the prominent role which remedial exercise plays in the extensive reconditioning programs now established by various agencies throughout the country. Therapeutic exercise has as its primary purpose not so much the development of muscle power, but rather the acquisition of ability to use muscles effectively in carrying out essential acts and skills.

In spite of the enormous amount of work that has been devoted to the changes incident to muscular contraction, there is still considerable divergence of opinion among competent students of the subject.

The physiologic fact that the redevelopment of muscle power, even in markedly atrophied muscles, depends on high resistive, low repetition exercises led De Lorme to devise a system of heavy resistive exercises. According to his program, one day each week the patient exerts maximal power to lift a suitable weight once. On the other days he lifts a weight which is no heavier than that which is maximum for ten repetitions. Striking results in improved muscle power have been obtained by this procedure.

Hellebrandt and her associates confirmed an older observation that unilateral heavy resistive exercise not only increases the strength of the exercised limb but brings about a similar concomitant effect on the contralateral unexercised limb. They found that the determining factor in this so-called cross education was the amount of effort expended rather than the duration of the exercise. This cross education may prove a useful therapeutic tool in cases in which voluntary control is unilaterally defective or in which contralateral muscle groups are temporarily inaccessible because of immobilization.

Evaluation of Ultraviolet Radiation of Sleeping Quarters as Supplement of Accepted Methods of Disease Control. H. G. duBuy; J. E. Dunn, C. S. Brackett.

Am. J. Hygiene 48:207 (Sept.) 1948.

duBuy and his co-workers evaluated the effectiveness of ultraviolet radiation for the control of the common cold and similar infectious diseases of the upper respiratory tract, considered to be air borne, among the occupants of the National Training School for Boys. The study extended over six years. The amount of radiation during the last two years was about five times that recommended commercially. The general bacterial population in the radiated dormitories was sometimes higher, sometimes lower, than that of the control dormitories. The data imply that the air layers are not efficiently mixed. More efficient mixing might have been obtained at the expense of a materially increased chance of raising dust and lint. The diseases incidence among the inhabitants of the radiated dormitories was sometimes higher, sometimes lower, than that of the control dormitories, with no evidence that ultraviolet radiation consistently effected a reduction in disease incidence. Since no significant effect of ultraviolet irradiation in controlling incidence of disease could be detected among about 400 inmates during six years, the beneficial effect of ultraviolet installations for general population use is questioned.

PHYSICAL MEDICINE ***

The following services are approved by the Council and the American Board of Physical Medicine

Hospitals, 34; Assistant Residencies and Residencies, 70

Name of Hospital	Location	Chief of Service	Patients Treated	Number of Treatments	Asst. Res. and Residencies Offered[4]	Beginning of Service (1946)	Length of Service Offered (Years)	Beginning Salary (Month)
United States Army								
†Letterman General Hospital★	San Francisco	A. V. Bateman	5,994	285,400	2	1/1	1–3	**
†Fitzsimons General Hospital★	Denver	J. H. Kuitert	3,606	119,005	2	1/1	1–3	**
Walter Reed General Hospital★	Washington, D. C.	E. M. Smith	8,573	238,036	3	1/1	1–3	**
†Percy Jones General Hospital★	Battle Creek, Mich.	A. E. White	28,849	346,505	2	.....	1–3	**
Veterans Administration								
Veterans Admin. Hospital	Chamblee, Ga.	W. Steiner	.....	20,400	1	7/1	1+	$275.00
†Veterans Admin. Hospital	Hines, Ill.	L. Newman	37,369	482,960	7	.....	1–3	275.00
Veterans Admin. Hospital	Framingham, Mass.	F. Friedland	10,130	194,794	2	7/1	1–3	275.00
†Veterans Admin. Hospital	Jefferson Barracks, Mo.	F. Ewerhardt	2,589	71,974	2	7/1	1+	275.00
†Veterans Admin. Hospital	New York City	H. Kessler	21,729	287,884	3	1/1, 7/1	1–3	275.00
†Veterans Admin. Hospital	Portland, Ore.	E. W. Fowlks	3,230	65,750	1	7/1	1–3	275.00
Nonfederal								
†Los Angeles County Hospital★[4]	Los Angeles	O. Huddleston	.....	14,633	2	Varies	2	.....
†White Memorial Hospital★	Los Angeles	F. B. Moor	500b	20,000b	1	7/1	1–3	147.33
Stanford University Hospital★[4]	San Francisco	W. H. Northway	.....	6,561	2	7/1	1–3	50.00
†University of California Hospital★†	San Francisco	F. Baker	.....	7,123b	1	7/1	1	50.00
University Colorado Medical Center								
†Colorado General Hospital★[4]	Denver	H. Dinken	2,905	64,050	1	Varies	1–3	75.00
†Emory University Hospital★	Emory Univ., Ga.	R. L. Bennett	7,836	.....	1	.....	1–3	.....
†Georgia Warm Springs Foundation	Warm Springs, Ga.	R. L. Bennett	.....	84,000	1	.....	1–3	.....
Michael Reese Hospital★[4]	Chicago	C. O. Molander	1,534	16,282	2	7/1	1	25.00
Passavant Memorial Hospital★[4]	Chicago	J. S. Coulter	7,784b	12,696b	2h	.....	1	.....
University of Kansas Hospital★	Kansas City, Kan.	Donald L. Rose	2,775	26,347	3	.....	1½	.....
†Massachusetts General Hospital★	Boston	A. L. Watkins	1,639b	16,265b	2	.....	1–3	41.67
†University Hospitals★[4]	Minneapolis	M. Knapp	7,677	12,141	2	7/1	1–3	115.00
Mayo Foundation	Rochester, Minn.	F. H. Krusen	.....	**	6	.....	3	.....
†Bellevue Hospital, Div. III—N. Y. Univ.★	New York City	H. A. Rusk	.....	.....	7	Varies	1	70.00
†Goldwater Memorial Hospital★[4]	New York City	H. Behrend	872	53,738	1	.....	1	120.00
†Hospital for Joint Diseases★[4]	New York City	J. Weiss	78,386	91,746	2	1/1	1+	40.00
†Montifiore Hospital for Chronic Diseases★	New York City	K. Harpuder	.....	.....	1	.....	1+	50.00
†Mount Sinai Hospital★[4]	New York City	.....	7,310	9,920	1	1/1, 7/1	1	50.00
†Presbyterian Hospital★[4]	New York City	W. B. Snow	77,771	221,144	1	.....	1	41.66
St. Luke's Hospital★	New York City	R. Muller	2,123	104,694	1	Varies	1	50.00
†Cleveland Clinic Foundation Hospital	Cleveland	W. J. Zeiter	16,267	39,919	1	7/1	1–3	100.00
†Hospital of the Univ. of Pennsylvania★	Philadelphia	G. M. Piersol	1,078	12,853	1	Varies	1	.....
†Medical College of Virginia, Hosp. Div.★	Richmond, Va.	.....	2,053	33,512	1	.....	1	46.50
†State of Wisconsin General Hospital★[4]	Madison, Wis.	H. D. Bouman	3,050	38,382	2	7/1	3	25.00

** Mayo Foundation Fellowships — The Mayo Foundation for Medical Education and Research, Rochester, Minn.: Three-year fellowships beginning quarterly leading to the degree of M.S., or Ph.D., with field named from the University of Minnesota in Physical Medicine; stipend $1,110 per year. Address applications to The Mayo Foundation, Rochester, Minn.

The star (★) indicates hospitals that are also approved for the training of interns. All hospitals on the approved intern list are likewise accredited for general residencies which represent general house staff assignments following the internship.

The dagger (†) represents temporary approval, *pending formal inspection*, in accordance with the plan for the temporary approval of residencies in specialties as announced in THE JOURNAL, A. M. A., March 2, 1946, p. 586.

4 Residencies open to women.

*** Rep. in part J. A. M. A. 137:71 (May) 1948.

IMPORTANT MEETINGS

You are urged to read the announcements of the various meetings of interest to physiatrists which appear in this issue.

Annual session of Congress at Cincinnati, inside front cover
Instruction Course, Cincinnati Session of Congress, page 193
Eastern Section Meeting of Congress, inside back cover
Western Section Meeting of Congress, page 211
Sessions on Physical Medicine, at AMA, page 254
Special exhibit on physical medicine, at AMA, page 238
International Congress on Rheumatic Diseases, page 242

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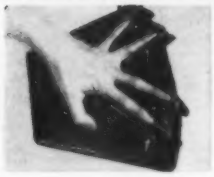

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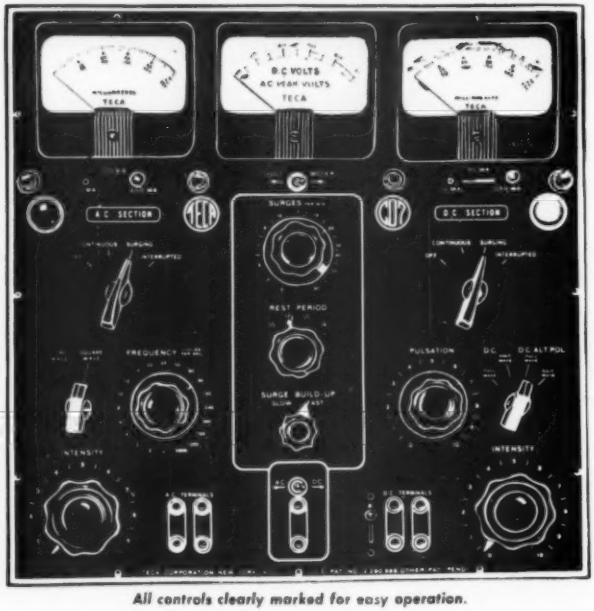

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SESSIONS ON PHYSICAL MEDICINE AND REHABILITATION

AMERICAN MEDICAL ASSOCIATION

Atlantic City, June 6 to 10, 1949

OCEAN ROOM, MARLBOROUGH-BLENHEIM HOTEL

Wednesday Morning, June 8 — Thursday Morning, June 9

Officers of Sessions: Chairman — Howard A. Rusk, New York; Secretary — Frank H. Krusen, Rochester, Minnesota

WEDNESDAY MORNING, JUNE 8, 9 A. M.

The principles of remedial exercise (Address of invited foreign guest)
SVEND CLEMMESEN, Copenhagen, Denmark

Coordination exercises and vitamin B_{12} for combined degeneration of the spinal cord in pernicious anemia
FRANK H. KRUSEN; BYRON E. HALL, and HENRY WOLTMAN, Rochester, Minnesota

The rehabilitation of quadriplegics
SAMUEL S. SVERDLIK; GEORGE G. DEAVER and HOWARD A. RUSK, New York

Physical medicine and rehabilitation in the Veterans Administration
LOUIS B. NEWMAN, Hines, Illinois

PANEL DISCUSSION ON CERTAIN COMMON PROCEDURES IN PHYSICAL MEDICINE AND REHABILITATION
HOWARD A. RUSK, New York, Moderator

What every physician should know about the teaching of crutch walking
GEORGE G. DEAVER, New York

What every physician should know about occupational therapy
SIDNEY LICHT, Boston, Massachusetts

What every physician should know about prescribing physical therapy
GORDON M. MARTIN, Rochester, Minnesota

What every physician should know about the office practice of physical medicine and rehabilitation
GEORGE M. PIERSOL, Philadelphia, Pennsylvania

What every physician should know about the hospital practice of physical medicine and rehabilitation
WILLIAM D. PAUL, Iowa City, Iowa

THURSDAY MORNING, JUNE 9, 9 A. M.

Physical medicine as related to rheumatic diseases (Address of invited foreign guest)
WILLIAM S. C. COPEMAN, London, England

What the Council on Physical Medicine and Rehabilitation has to offer the physician
JOHN S. COULTER; HOWARD A. CARTER, and FREDERICK T. JUNG, Chicago, Illinois

Physical treatment of common lesions of the shoulder (Address of invited foreign guest)
WILLIAM TEGNER, London, England

Physical medicine in peripheral vascular diseases
WILLIAM BIERMAN, New York

PANEL DISCUSSION ON CERTAIN COMMON INDICATIONS FOR PHYSICAL MEDICINE AND REHABILITATION
HOWARD A. RUSK, New York, Moderator

What every physician should know about rehabilitation of the crippled child
ALFRED R. SHANDS, JR., Wilmington, Delaware

What every physician should know about the physical treatment of backache
HANS KRAUS, New York

What every physician should know about physical medicine and rehabilitation in the prevention of chronic invalidism
F. A. HELLEBRANDT, Richmond, Virginia

What every physician should know about physical fitness
ROBERT C. DARLING, New York

What every physician should know about physical medicine and rehabilitation for industrial injuries
DONALD A. COVALT, New York

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GRADUATE COURSE

Physical Therapy and Occupational Therapy In the Care of Poliomyelitis

This course is open to graduates of approved schools in physical therapy and occupational therapy. Such graduates must be members of the American Physical Therapy Association and/or the American Registry of Physical Therapy Technicians, and Occupational Therapy Association.

Tuition: None. For Scholarship to Cover Transportation and Maintenance Contact, National Foundation for Infantile Paralysis, 120 Broadway, New York 5, New York.

Entrance Dates: First Monday in January, April, July and October.

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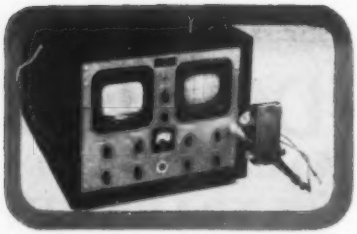

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EASTERN SECTIONAL MEETING

AMERICAN CONGRESS OF PHYSICAL MEDICINE

SATURDAY, APRIL 30, 1949

Academy of Medicine, Northern New Jersey

91 Lincoln Park **Newark, New Jersey**

PROGRAM

SATURDAY AFTERNOON, APRIL 30, 1949, 1:30 P. M.

Opening Remarks and Salutation, BROR S. TROEDSSON, M.D., Chairman of the Scientific Program of the New Jersey Society of Physical Medicine.

Amputations: Functional Problems at Various Sites as They Affect the Stump and Prostheses, HENRY W. KESSLER, M.D., Director of the Kessler Institute for Rehabilitation, West Orange, New Jersey.

Pathologic Gaits and Their Therapeutic Implications, JESSIE WRIGHT, M.D., Director, D. T. Watson School of Physiotherapy, Leetsdale, Penna.

Physical Medicine in a Changing Medical World, E. M. BLUESTONE, M.D., Director of Montefiore Hospital, New York, N. Y.

The Role of Physical Medicine in Diagnosis and Prognosis of Arterial Vascular Disease, MAX K. NEWMAN, M.D., Director of Physical Medicine Rehabilitation, Grace Hospital and Wayne University, Detroit, Mich.

Resistive Physical Technics in Neuromuscular Rehabilitation, RENE CAILLIET, M.D., Medical Supervisor, Kabat-Kaiser Institute, Washington, D. C.

EVENING SESSION — 6:00-9:00 P. M.

Military Park Hotel, 16 Park Place, Newark, New Jersey

DINNER — 6:00-7:15 P. M.

SYMPOSIUM ON REHABILITATION OF THE HEMIPLEGIC PATIENT

Moderator — WILLIAM BENHAM SNOW, M.D.

Discussion of the Problems Presenting in Patients with Hemiplegia, Prognosis Toward Recovery and Indications for Treatment, H. HOUSTON MERRITT, M.D., Director of Medical Service, Neurological Institute, New York, N. Y.

Speech Problems and Speech Training in Hemiplegic Patients, MARION CASS, Ph.D., Instructor in Speech Therapy, College of Physicians and Surgeons, Columbia University College of Medicine, New York, N. Y.

Physical Methods During the Subacute and Convalescent Stages of Hemiplegia, A. DAVID GUREWITSCH, M.D., Assistant Director, Physical Therapy, Columbia Presbyterian Medical Center, New York, N. Y.

The End-Rehabilitation of the Hemiplegic to Maximum Self-Sufficiency, SIDNEY LICHT, M.D., Regional Director, Veterans Administration, Boston, Mass.

ROUND TABLE DISCUSSION —

OPTIONAL OFFERING: Those attending the meeting are invited to visit the Kessler Institute for Rehabilitation, Pleasant Valley Way, West Orange, New Jersey. Inspection of the Institute, a discussion of how it functions and a talk by Miss Signe Brunstrom on "Rehabilitation of Severely Handicapped Individuals," will be included.

Those desirous of visiting the Institute will meet at the office of Dr. Henry Kessler, 53 Lincoln Park, Newark, New Jersey, at 10:00 A. M., Saturday, April 30, 1949. Transportation to the Institute will be provided and luncheon will be served to those attending as guests of Dr. Kessler. Ample time will be allowed to return for the Afternoon Session which starts at 1:30 P. M.

Kindly notify Dr. William B. Snow in advance of the meeting if you intend to visit the Institute of Rehabilitation, so that adequate transportation may be supplied.

OFFICERS OF THE SECTION

W. B. SNOW, M.D., Chairman
180 Fort Washington Avenue
New York 32, N. Y.

N. D. MAURIELLO, M.D., Secretary
120 South Franklin Street
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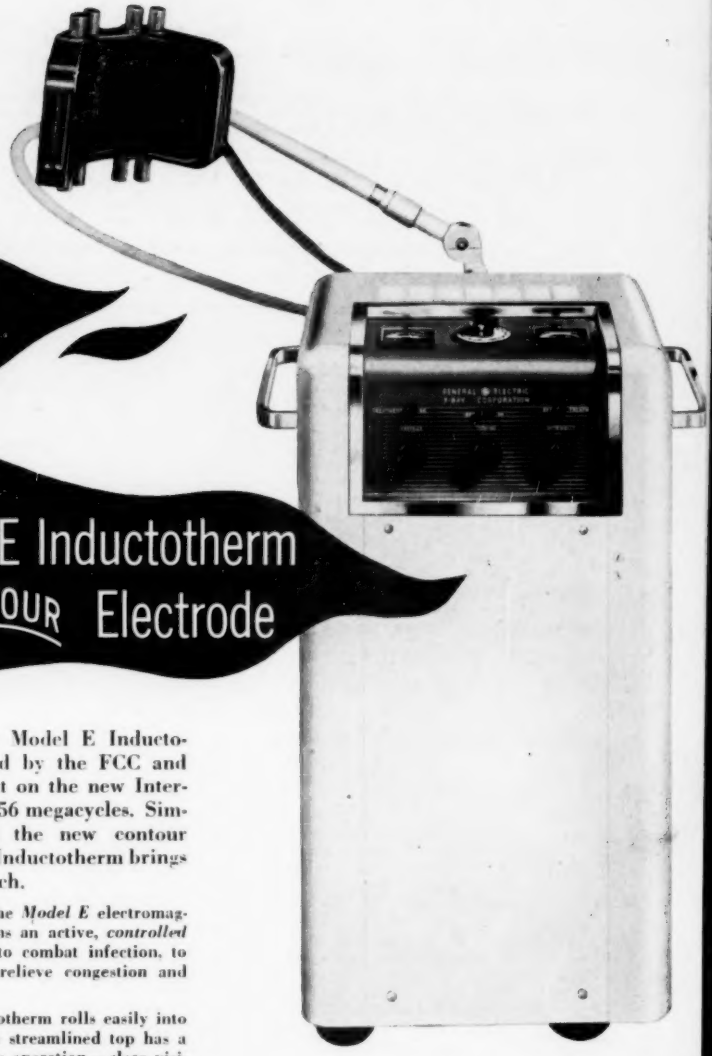
Physicians, other professional personnel and their guests are welcome.

27th Annual Session, Netherland Plaza Hotel, Cincinnati, Ohio,
September 6, 7, 8, 9, 10, 1949.



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